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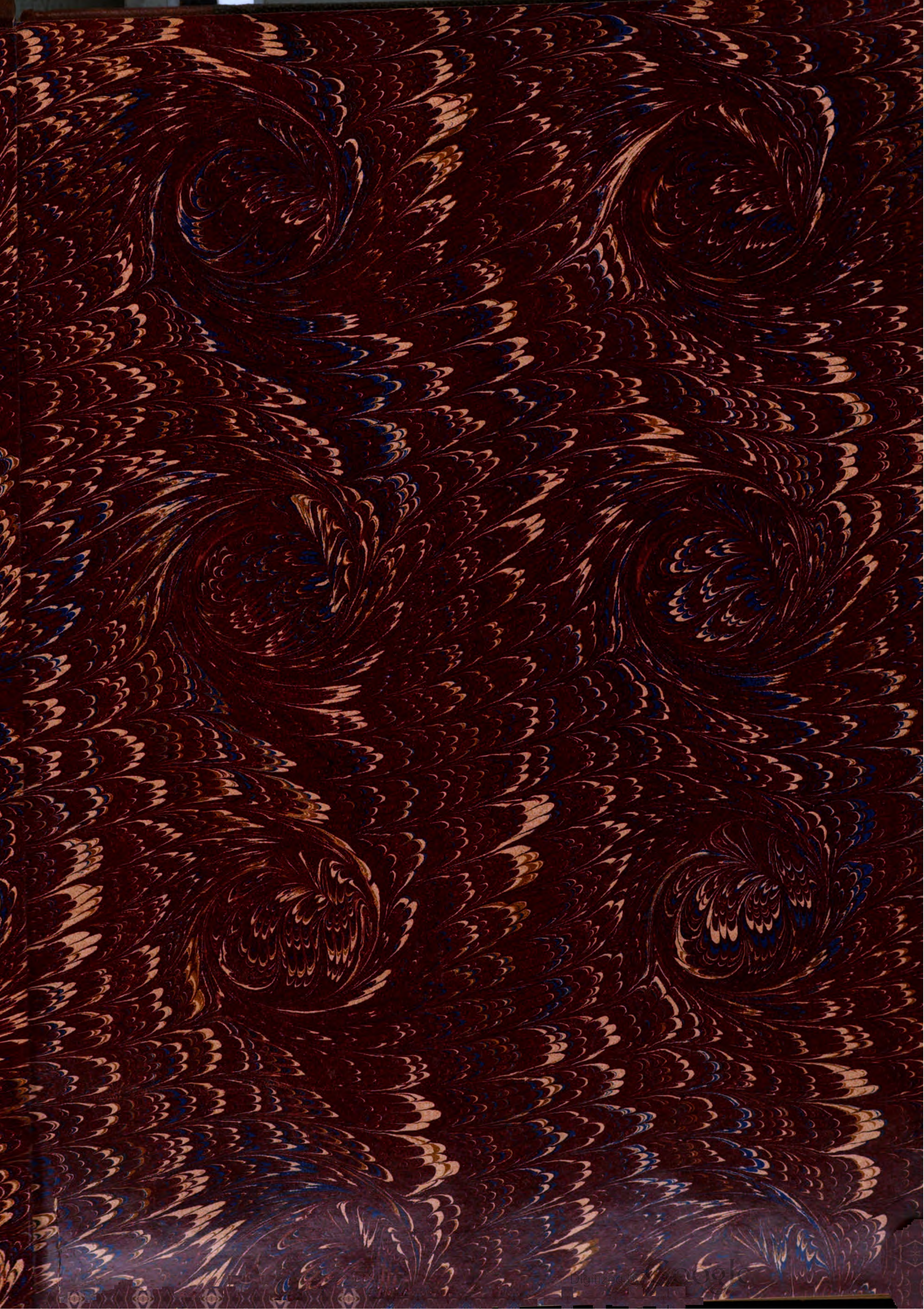

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*This name should be Harold M. Wolf; a very illegible signature was the cause of the error.

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CENTRAL STATION OPERATED BY GAS POWER.

PLANT OF THE BRADFORD ELECTRIC LIGHT AND POWER COMPANY.

THE applicability of gas engines to central station service is a subject of growing importance to the management of small as well as large electric light and power systems, in districts so situated that the price of coal prohibits a reasonable profit upon the station output, when sold at a rate sufficiently low to encourage the general use of electricity. It has been stated that the cost of gas power may be reduced from one-third to two-thirds that of steam power, depending upon the character of the equipment. In the abstract, this would appear difficult of substantiation by reason of the high efficiency reached by well designed modern steam plants, but the fact remains that gas power plants are regularly performing a duty of one effective horse-power per hour above the thermal equivalent of one pound of good steam coal.

A particularly instructive example is offered by the power station of the Bradford Electric Light and Power Company, of Bradford, Pa. The station is of comparatively small capacity, and in some mechanical features does not embody the most advanced engineering features. It is, however, representative of the class of central stations usually found in towns of corresponding size, and the results secured, since the introduction of gas power, give sufficient evidence of its general efficiency.

The company equipped its system and began operations in 1889, supplying single-phase 110-volt, alternating current, for incandescent lighting, constant current for direct current open arcs, and direct current at 550 volts for street railway use. The station building was a wooden structure containing about 575 horse-power capacity in engines, which were of the simple high-speed type, running non-condensing. Belt transmission was used throughout. The generators comprised T. H., arc machines, 133 cycle, alternating-current generators and a direct-current railway generator. Steam was furnished by horizontal return tubular boilers fired by natural gas obtained from a local distributing company at a nominal figure. Flat rates prevailed in all classes of service.

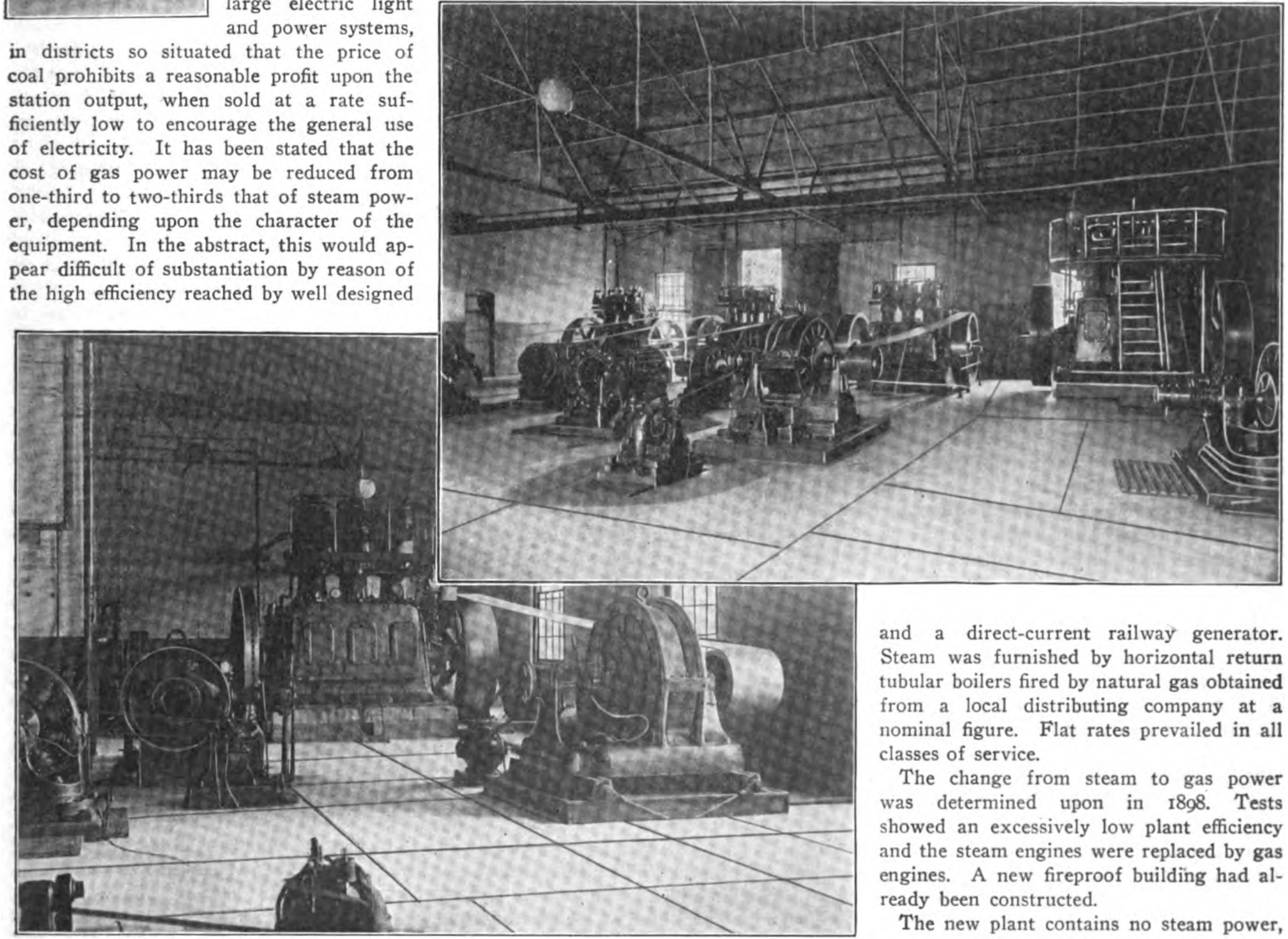

FIG. 1.—GENERATING EQUIPMENT OF THE BRADFORD ELECTRIC LIGHT AND POWER COMPANY.

The change from steam to gas power was determined upon in 1898. Tests showed an excessively low plant efficiency and the steam engines were replaced by gas engines. A new fireproof building had already been constructed.

The new plant contains no steam power, as may be observed from the interior views. Belt transmission was retained, as the expense necessary in changing from a high to a low frequency system, was unwarranted. An entirely new generator and transformer equipment had, of course, to be provided. The railway load was dropped and the alternating-current generator capacity increased to care for the gradual increase in demand upon the plant.

Flat rates were abandoned as fast as possible, and meter rates substituted. In 1902 the proportion of meter revenue to the total revenue was approximately 16 per cent, and this proportion is rapidly increasing with the lapsing of flat rate contracts. A considerable day load is furnished by single-phase motors in local factories. The meter rates range from fifteen cents to six cents per kilowatt-hour. Domestic lighting averages about 12 cents or 11.8 cents net. The system thus compares favorably in cost of current to the consumer with systems operated upon a much larger scale, and furnishes ample evidence of the general economy of gas power. At the present time there are over 4500 connected incandescent lamps of 16 candle-power and 164, 9.6 ampere open arc lamps, but the incandescent load will shortly be increased to an equivalent of over 6000 lamps.

The new station building is a substantial brick structure with concrete floors and steel roof trusses. By reason of the fireproof construction, no insurance is carried. The front of the building is occupied by offices with the engine-room immediately in the rear. A small space is reserved for a machine shop and storage of duplicate parts. Five generating units are at present in service, four regularly and one held in reserve. The engines are all of the Westinghouse three-cylinder vertical type, in two sizes, 13 by 14 ins. and 15 ins. by 22 ins., respectively.

Two engines each drive two 50-light arc generators, a third one 70 kw., alternating-current generator, and the two large engines 170-kw. and 180 kw., alternating-current generators, respectively, the 120-kw. unit being usually held as the reserve. A small 8-h.p. Otto engine operates continuously a triplex pump for providing circulating water and at intervals a 5 in. by 6 in. air compressor. The entire equipment occupies approximately 6.5 sq. ft. per brake horse-power.

The main engines receive gas from a main extending the length of the room along the lower chord of the roof trusses. A pressure-reducing valve in the station main lowers the pressure from 50 to 60 pounds to 8 ounces. Individual regulators in each engine supply pipe reduce the pressure to that of the atmosphere before the gas enters the mixing valve. The calorific value of the gas is about 1175 B. T. U. per cubic foot, and a mixture of 12 to 1 gives the best results.

Ignition current is furnished at 100 volts directly from the generator exciters. Two 100-volt 16-c.p. lamps in series with the igniters limit the current to about one ampere, which gives at this voltage sure and positive ignition. As the platinum igniter tips are sometimes found to be unequally worn after service for a considerable time with current in one direction, a reversing switch is inserted in the igniter feeder. At the end of the day's run, the switch is reversed and the current enters the igniters at the other tip. With this arrangement, the igniter tips last for eight or nine months. The point of ignition is set about 20 degrees in angular advance of the crank, on account of the richness of the gas.

Cooling water is also drawn from an overhead main supplied from a driven well upon the premises. The cylinder heads and exhaust valves are cooled by separate streams in order to maintain more uniform temperature in the working parts. These streams discharge into the exhaust header of the engine, thus keeping it at a safe temperature. The exhaust pipe for each engine extends through the building and to the roof, a water pocket draining off the cooling water which flows into the sewer.

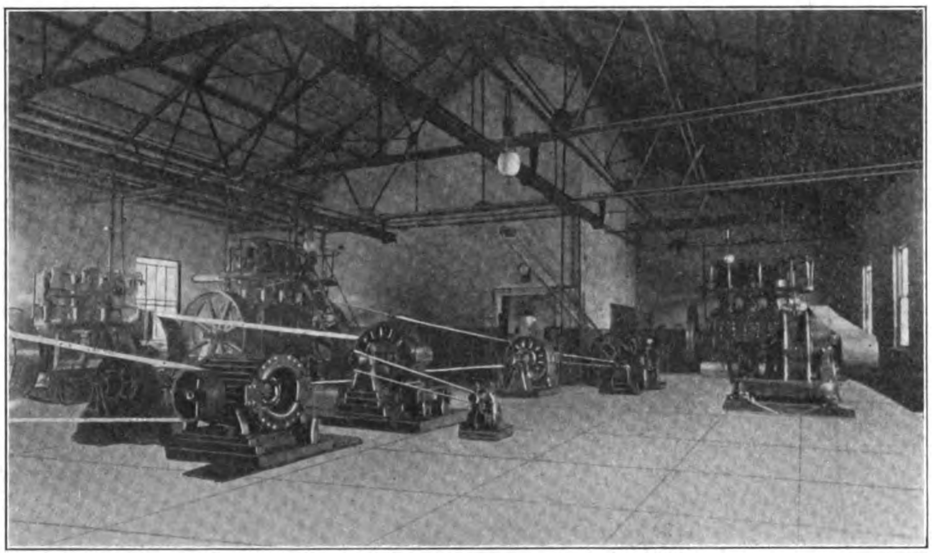

FIG. 2.—GENERAL VIEW OF ENGINE ROOM.

The consumption of cooling water can be estimated from a three weeks' run on city water, at a time when the pumping plant was out of commission. During this period the plant used an average of 63,500 gallons per day at a cost of 6 cents per thousand gallons, or 1.6 gallons per horse-power-hour capacity. No use has heretofore been made of this water, but it is contemplated that the use of natural gas for heating the station building will be discontinued and radiators installed instead, utilizing the waste heat from the jackets. The cooled water may then be returned to the jackets with such proportion of fresh water as will insure the proper cylinder temperatures.

A simple means for maintaining a constant though small head of cooling water on all parts of the engine consists of an inverted U in the discharge pipes from each part, the bend of the U being a few inches higher than the cored passages in the engines. Thus the engine may not be carelessly started up without cooling water.

Each engine is started by compressed air at 150-pound pressure stored in a long steel tank resting upon the lower chord of the roof trusses and supplying a distributing main similar to the gas and water mains. Starting is easily accomplished and load placed upon the generator within two minutes, but the operation may be performed in half the time if necessary. The air compressor is usually operated about one hour per day, as indicated by a telltale pressure gauge. The gauge normally registers 150 pounds, but should the pressure rise to 160 or fall to 140, the index makes contact with small brass pins which complete a circuit through a signal lamp placed in a prominent position in the engine room. Rise in pressure is indicated by a white light, and fall in pressure by a red light. Assuming an average operation of one hour per day, the air supplied at 150-pound pressure is 20 cubic feet, or .025 cubic feet per horse-power capacity, including leakage in piping, valves, etc. This represents the air consumption required to carry the entire plant through its daily cycle of operations and is evidently an insignificant item of expense.

The engines are regularly inspected for repairs twice each year, at which time pistons are lifted out and rings examined, bearings and boxes tightened up and exhaust valves reseated or replaced if necessary. These valves usually run about one year without reseating. A set of valves examined in November ran for 14 months and were then still in good condition.

Previous to the replacement of the steam plant, a 24-hour economy test upon the station showed a gas consumption referred to the engines of 57.09 cubic feet per indicated horse-power, at an average load of 250 horse-power. The engines were indicated every five minutes and the results represent average daily load conditions. Assuming an average engine efficiency of 85 per cent, generators 90 per cent, and transmission 95 per cent, the consumption of gas at the boilers per electrical horse-power was about 75 cubic feet, or 82,500 B. T. U.

The performance of the present equipment may be observed from several sources. A test upon the gas engines, shortly after they were installed, showed a gas consumption of 125 cubic feet for 760 watt-hours, equivalent to 12.27 cubic feet per electrical horse-power at full load, which is but 17½ per cent of that of the former steam plant. The accompanying curve sheet shows the economy determined at the builders' works under load tests with a Prony brake. At full load, the gas consumption was 10.9 cubic feet, or 9500 effective

B. T. U. per brake horse-power. It is apparent that the curve of total gas used is nearly a straight line, departing therefrom only on heavy overloads and resembling somewhat the total water rate curve of the steam turbine.

In the present service the engines are all considerably underloaded. The heaviest demands of the arc system furnishing but about 62 per cent of the engine rating. The results are consequently less favorable than if approximately full loads were obtainable. More recent figures were obtained from observations extending over six months from March to August, 1903.

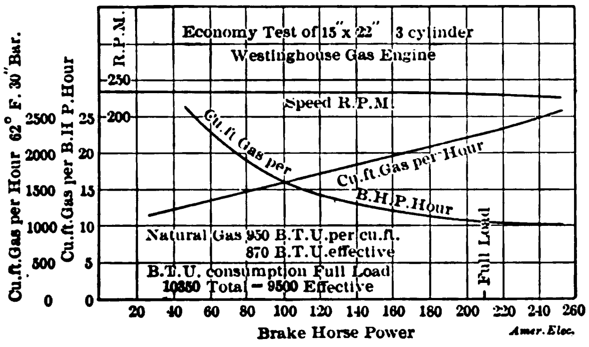

FIG. 3.—ENGINE TEST CURVES.

The total output in kilowatt-hours was 3,257,302, gas consumed 7,759,000 cubic feet, including heating of building, or 23.8 cubic feet per kilowatt-hour, 17.6 cubic feet per electrical horse-power-hour. As the gas could not be measured by a separate meter, it was estimated at about 750,000 cubic feet. Thus the net gas consumption on this estimate amounts to 21.5 cubic feet per kilowatt-hour or 16 cubic feet per electrical horse-power per hour. At an average plant efficiency of 75 per cent this is equivalent to an economy of 12 cubic feet per brake horse-power-hour, or a duty of 14,100 B. T. U.

The accompanying load curves represent typical Saturday and Sunday loads during the present season; the curve represented by the full line showing the incandescent load on Saturday, November 28, while the load curve of the following Sunday is shown dotted. The curves for the arc service on the same dates are shown in Fig. 6. Fig. 7 is a curve showing the meter rates charged for incandescent current. A discount of 10 per cent is allowed for prompt payment.

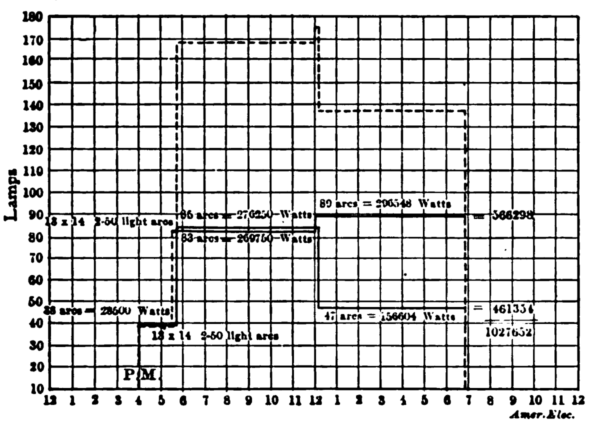

FIG. 6.—TYPICAL STATION LOAD, ARC SYSTEM.

The comparative cost of station operation by steam and by gas power is shown by the following figures which, although not stating actual output, represent comparative results. The figures are based upon averages of two years' operation of the steam plant and four years of the gas plant. The saving in total operating cost due to the latter was 33.9 per cent of the cost of operating the steam plant. During the six years covered by the records, there was an increase of 18.5 per cent in revenue, which however, does not represent the true rate of increase in output due to transition in rates. The actual increase is estimated to be fully 30 per cent. Further, gas is purchased at a flat rate with a minimum of 30,000,000 cubic feet. In the face of the increase in output, the gas consumption of the station has decreased to 16.5 per cent of the original amount in the steam station. The minimum rate was reached three years ago, and at the present time is considerably below resulting in a cost per cubic foot 60 per cent greater than by the original flat rate. The total operating cost per horse-power capacity per year is $36.60 for the steam station and $14.80 for the gas station. The latter figure, if credited with actual cost of fuel, would be approximately $14. This includes gas, labor, oil waste and packing, and repairs.

ECONOMY TEST.

Compression 120 lbs.				
Speed	227	229	232	233
Gas per B. H. P.	2720	2410	1681	1131
B. H. P.	254	220	112	27.5
Gas 62 deg.	10.7	10.9	15.0	....

The following summary includes fixed charges, *i.e.*, interest, 6 per cent on land and buildings; depreciation of buildings, 3 per cent; depreciation of machinery, 10 per cent:

	Steam plant.	Gas plant.
Per horse-power year capacity.		
Operating cost	$36.60	$14.80
Fixed charges	22.90	16.18
	$59.50	$30.98
Saving		$28.52
Saving, per cent		47.9

Assuming an average yearly station load factor of 17.5 per cent, this total cost per horse-power-hour is $.0373 and $.0099, respectively. The heretofore incomplete records of the system permits no more accurate analysis but the general deduction from the operating expenses is that the true cost of power has been reduced by one-half in the plant. The Bradford system is under the efficient management of Mr. J. H. Rose, whose appreciation of the merits of the gas engine has resulted in the successful operation of the station.

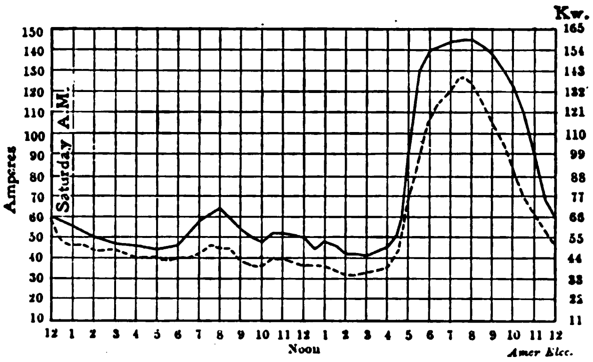

FIG. 5.—TYPICAL STATION LOAD, INCANDESCENT SYSTEM.

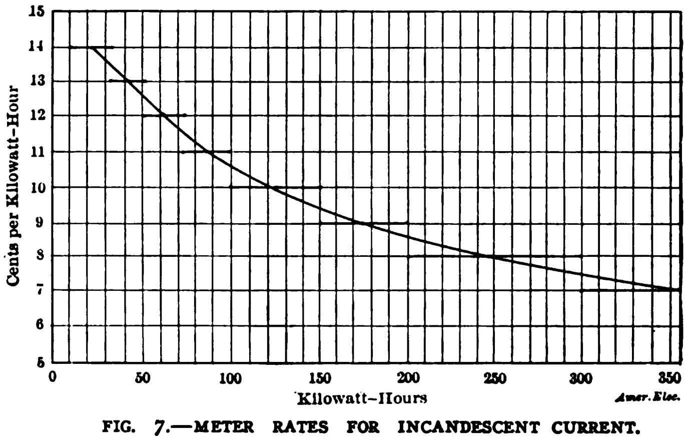

FIG. 7.—METER RATES FOR INCANDESCENT CURRENT.

◆◆◆

THE CRUDE OIL ENGINE.

BY GEORGE E. WALSH.

The efficiency of the crude oil engine for driving portable or small generator plants has slowly claimed recognition within the past year, and the general adoption of this form of power producer in certain lines of work is somewhat remarkable. The development of a high-power engine that could use crude or unrefined petroleum has been somewhat slow. The use of refined, high-grade oil did not promise such economy as the gas engine, and it was considered somewhat doubtful whether an internal combustion engine could be developed which would burn the crude oil. The difference between the cost of the crude and refined oil is so great that it practically determines the success of this form of engine.

The cost of oil varies all the way from

3 cents a gallon to 10 and even 15 cents; but crude oil in the oil regions can be obtained for 2½ cents a gallon or less. With fuel at this rate the cost of generating power is probably the lowest on record. In Texas and on the California coast crude oil engines are coupled to generators which show a fuel cost considerably less than a fraction of a cent per electrical horse-power-hour. Some experiments have placed the cost of operation as low as 0.15 cent per horse-power-hour, but this is exceptional if not impossible.

In mining for petroleum the cost of the crude oil is always one of the least important items. The cost of refining enhances the price of the oil and makes it a less formidable competitor with coal. This refined oil delivered to Northern manufacturing centers always costs more than double its cost at the producing centers. The refined oil always leaves a certain percentage of inferior, low-grade oil behind which can only be utilized by producing some of the series of by-products which in late years have attained a considerable commercial value. Some wells produce such a low grade oil that in the past it hardly paid to attempt to refine it. The Russian petroleum deposits are even poorer, as a rule, than those found in this country.

The question of utilizing all grades of oil for fuel, even the poorest crude petroleum, has offered plenty of difficulties for the inventor to overcome. There is first the question of low ignition temperature to solve. In the highly heated cylinder a premature explosion might cause disaster and throw the engine out of service. To prevent this, water vapor is added to the oil spray or mixture of air and atomized oil. The presence of water vapor gives the mixture a high specific heat and permits of a much higher degree of compression without danger of premature explosion. Some of the jacket water is vaporized and passes into the cylinder head with the oil spray and air. The steady flow of the water keeps the temperature of the gases in the chamber down to 150° to 170° Fahr. The water, which is instantly vaporized in the chamber mixes readily with the oil spray.

Another difficult feature of using crude oil has been the tendency to form carbon deposits in the engine cylinder, which in a very short time would put the machine out of service. These carbon deposits appear more abundantly when the poorer grades of crude oil are used, and in some cases they are so great that only specially-fitted engines can be used with advantage. In order to use these grades of oil, resort has been had to automatic scavengers for cleaning out the cylinder after each compression and explosion.

The economy and reliability of the oil engine depends to a large extent upon the mixer and the water jacket. The mixer must be thorough and automatic in action. Every drop of fuel entering the cylinder without being perfectly vaporized and mixed with air is wasted. The perfect mixture and vaporization are obtained by a number of different methods, but most designers seek to perform this work directly in the cylinder itself, doing away with mixing valves and carburettors. Mixing and vaporizing directly in the cylinder has the advantage that there is no danger of mixing valves or carburettors getting clogged, and imperfect mixing of the oil and air resulting therefrom. The fuel efficiency of the engine is thus directly dependent upon this part of the design.

THE GAS ENGINE SITUATION IN EUROPE.

BY G. L. CARDEN.

It seems to be fairly well recognized that Germany to-day is leading in the development of high-powered gas engines, and when we say Germany, we refer to results achieved by students of German technical schools. At the Paris Exposition in 1900, the Société Anonyme John Cockerill, of Seraing, Belgium, exhibited a 650-h.p. gas engine, and probably no one item in the machinery department of that Exposition excited more interest. The head of the Cockerill house at present is Director General A. Greiner, and many of his assistants are Germans. This establishment has now under construction a 3000-h.p. gas engine, and this machine will at the time of its installation in the spring of 1904 probably be the largest size of gas engine in service in the world. It is an interesting fact that the rights for the manufacture of the Cockerill product were acquired recently by the Wellman - Seaver - Morgan Company, of Cleveland, Ohio.

The principal dimensions of the Cockerill 3000-h.p. engine are: Length over all, 67 feet 1⅛ inches; extreme width, 21 feet 4 inches; diameter of cylinders, 51 inches; length of stroke, 55 inches; diameter of flywheel, 26 feet 3 inches; revolutions per minute when developing three thousand horse-power, 85. This engine is of the horizontal two-cylinder tandem type. Its prototypes at the Cockerill works use blast furnace gas purified by passing through water reservoirs; but the engine is also adaptable to service in connection with almost any form of poor gas that is practically free of tar. In the winter of 1902-3 the Cockerill works were using in actual service at their plant three 700-h.p. gas engines, and the statement was made to the writer that within eighteen months the Cockerill works would probably not have in service any other type of power generators than gas engines.

To understand better the significance of the announcement of a 3000-h.p. gas engine, one must bear in mind that the 650-h.p. Cockerill engine at the Paris Exposition in 1900 was regarded as little short of a wonder. At the Pan-American Exposition at Buffalo in 1901, a 650-h.p. engine was also exhibited; in the latter case the manufacturer was an American. It will be seen from this that in Europe the gas engine has developed from 650 to 3000 horse-power in three years time. In America, the largest types of gas engines now observable are, so far as I am aware, of foreign origin. The Allis-Chalmers Company, of Milwaukee, has recently acquired, it is announced, the gas engine as produced by Vereingte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg A. G., and is prepared to manufacture engines of the Nürnberg origin of 1850 horse-power. This Nürnberg machine is like the Cockerill engine in general appearance, being of the horizontal two-cylinder tandem type. It has a length over all of 60 feet and an extreme breadth of 19 feet 4 inches. Its flywheel measures 18 feet in diameter, and when developing 1800 horse-power it runs at 90 revolutions per minute.

The firm of A. Borsig, Tegel, near Berlin, has recently undertaken to manufacture the Oechelhauser gas engine in sizes of 500, 1000 and 1750 horse-power. The Borsig firm is now working in connection with Julius Pintsch, of Berlin, the Pintsch firm undertaking to supply the gas producers. A Borsig installation shows a three-furnace gas producer in close proximity to the engine, and the area of the space occupied by the producer is but little larger than the space occupied by the engine itself. The Germans permit the gas producer to be placed within 18 inches of the wall partition, and the practice is observed of separating the engine room and gas producer merely by an ordinary partition. For an engine of 1750 horse-power, the Pintsch people install a gas producer capable of developing 2400 horse-power. No reservoir is employed; the gas passes direct from the furnaces through a washer to the engine.

When using anthracite coal of proper quality, the Pintsch people assert that there is no difficulty in developing 1750 horse-power on 1575 pounds of coal per hour; for periods when the engine is not in actual operation, as, say, between night and morning, 50 pounds of coal per hour is used merely to keep the furnaces warm. It will be seen from these figures that the Borsig engine combined with a Pintsch gas producer is capable of developing a horse-power on less than one pound of coal an hour.

The principal gas engine makers of Germany are included in the firm known as Gasmoterenfabrik Deutz, near Cologne. This firm probably turns out more gas engines than any other firm in the Fatherland, and its 900-h.p. engines have earned a splendid name. When the writer visited Deutz, during the past year, he was informed that the Deutz establishment expected to be able by 1905 to have in actual service a gas engine of 6000 horse-power.

The Deutz 900-h.p. engine is of the double-acting four-cycle type, and differs considerably in appearance from the usual form of gas engine, being in many respects more like a steam engine in its general arrangement, as an inspection of the accompanying engravings will show. Referring to the illustrations, the exhaust valves are indicated by the letter *E*, and the general inlet valves by *I*. The exhaust valves, as Fig. 2 plainly shows, are opened by the usual cam and link arrangement actuated from a secondary or lay shaft *S*, and are closed by means of

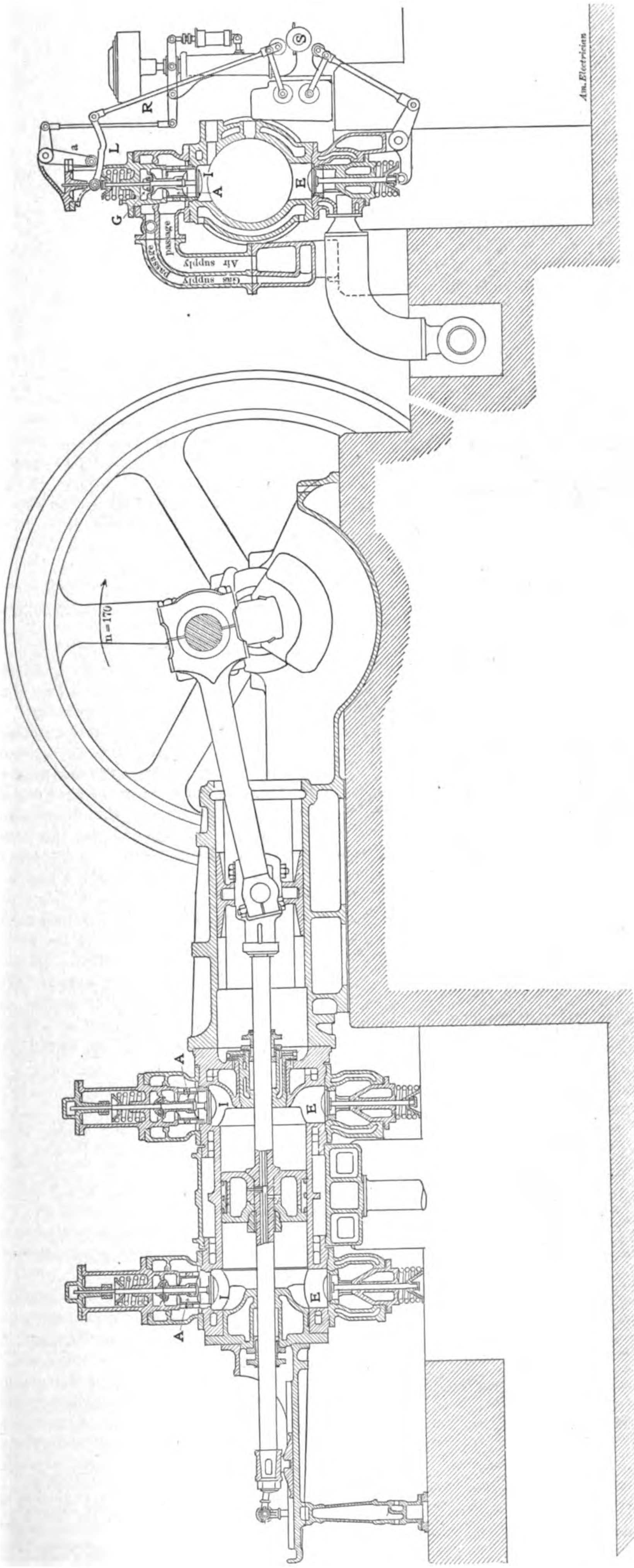

FIG. I.—ELEVATION AND END VIEW OF THE DEUTZ DOUBLE-ACTING FOUR-CYCLE GAS ENGINE—FIG. 2.

springs. The admission valves are similarly opened by cams and linkages, but their travel is varied by the governor through the medium of the bell-crank arm *a*, which carries a roller at its extremity, this roller serving as the fulcrum for the lever *L*, operated by the cam mechanism. Obviously, the position of the roller determines the ratio between the travel of the reach rod *R* and that of the admission valves, and therefore regulates the quantity of explosive mixture admitted to the cylinder. The admission valves are composite; the air valve *A* is of the piston variety and controls the entrance of air from the supply pipe in the usual manner. It carries at its upper end a poppet valve extension which controls the admission of gas through the port *G*, the gas and air being mixed in the valve chamber. It is stated that the action of the governor is so sensitive that the speed fluctuation does not exceed one-half of one per cent when the load is abruptly increased or decreased 25 per cent. The variation in speed between no load and full load is generally not more than three-quarters of one per cent.

The double-acting construction involves the use of stuffing boxes, which have been used very little heretofore in gas engine construction, and experience shows that these stuffing boxes, contrary to the general expectation prior to their actual use, cause no trouble whatever. Fig. 1 gives an excellent idea of the general construction of the engine. The piston is packed by rings of a special type, and the rod and piston are hollow, of course, to permit water cooling. The cooling is very carefully arranged; the cylinder and cylinder lid and the valve, discharging valve and discharging pipe receive separate cooling water so that the temperature can be regulated independently. A lever pump is employed to force the water through the jackets. The starting of the engine is effected by compressed air. These double-acting engines are turned out at Deutz in sizes of 150 horse-power per cylinder and upward. The two-cylinder machines are recommended.

Körting Bros., Körtingsdorf, near Hanover, are not building any engines of their type at the Körtingsdorf shops of more than 500 horse-power. The writer was informed at Körtingsdorf that the facilities of the shops there did not permit of work larger than this. The American rights for this engine are now being developed, and engines of considerably larger power are being manufactured.

In England the Crossleys, of Manchester, have turned out more than twenty thousand gas engines of all sizes; the majority being, however, very small units. The Crossleys are now going in for engines of considerable horse-power, and they, too, are employing poor gas. At Sandiacre, Birmingham, and at Reddish, the writer found shops turning out 500-h.p. gas engines. These sizes seem to be recognized as standard in the United Kingdom, and Mond gas and the Duffield and the Norris systems are now much in favor. The rights to manufacture Crossley engines in the United States, it is stated, have been acquired by local interests.

THE OECHELHAUSER GAS MOTOR.*

BY A. BORSIG.

During the past few years much attention has been devoted to the better utilization of the inferior fuel of low calorific value. This has particularly been the case since the discovery of the fact that the gases from blast-furnaces form an excellent agent for driving gas engines. To-day, therefore, every imaginable fuel is being tested as to its gas-producing qualities with the object of utilizing the gas obtained in explosive motors.

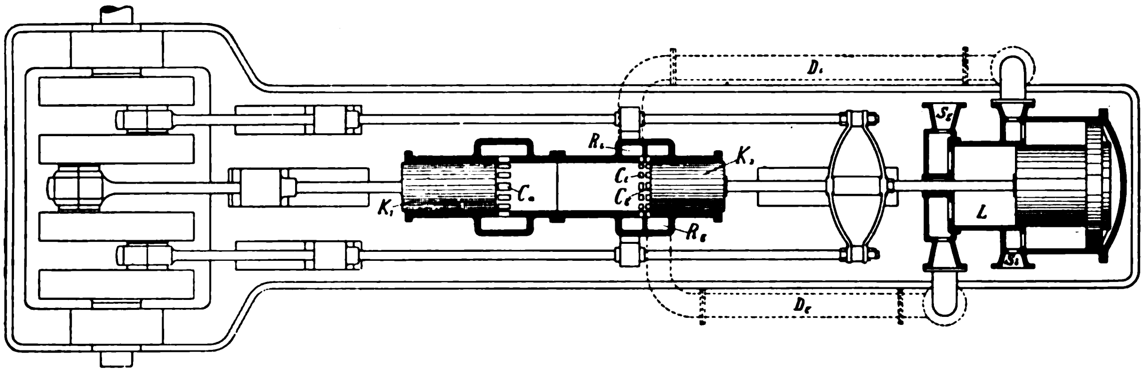

FIG. 1.—SEMI-SECTIONAL PLAN VIEW OF THE OECHELHAUSER GAS MOTOR.

Until a few years ago engineers had not succeeded in obtaining high efficiencies with a single cylinder. Attempts were made to adapt the various existing systems to the increased demands, the result being more or less complicated designs, for what proves successful experimentally is by no means found to be so when carried out on a large scale. The task still remained for the theorist and the practical engineer to conceive and construct an engine fulfilling all the requirements of trade industry; simple, safe in its working, and enabling large powers to be developed in one cylinder of not too large a size. To-day engines are being built, capable of producing continuously over 2000 horse-power in a single working cylinder.

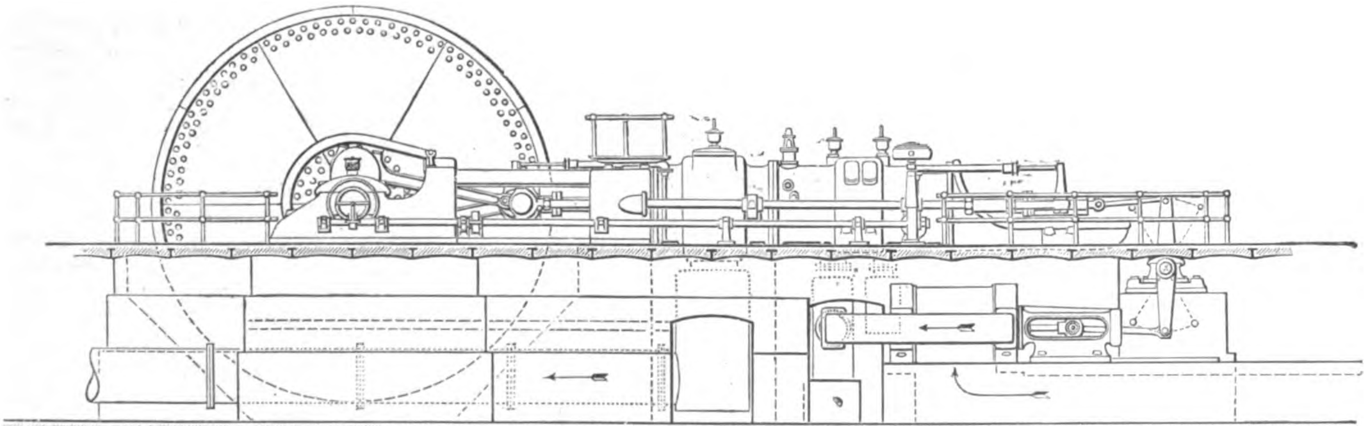

FIG. 2.—ELEVATION OF AN OECHELHAUSER GAS ENGINE.

Following upon the exhaustive investigations of Herr Fritz Lurmann and Professor E. Meyer many iron-workers are gradually displacing their steam engines by gas motors, the latter utilizing the furnace gases three times as well as the steam engines. The results obtained by the experimenters just mentioned show that if the whole of the gases is employed to drive gas engines, about 28 horse-power per ton of pig-iron per day is available for power purposes. The gases from coke-ovens may be similarly well utilized.

Smelting and coke-works, therefore, will in time constitute large central power stations, supplying light and power to the adjacent mines, rolling-mills and other works, and to the neighboring district generally.

Gas engines can also be driven by any kind of producer gas, and before long gas producers will be constructed capable of making a serviceable gas from fuels which are at present generally regarded as being too poor for profitable employment.

Among the numerous types of gas engines, the simplest is unquestionably W. von Oechelhauser's two-stroke cycle motor. As is shown in Fig. 1, two pistons, K_1 and K_2, work in opposite directions in a long cylinder open at both ends and provided with ports *Ca*, *Cl*, and *Cg*. During their motion in the outward direction the pistons uncover the ports consecutively, whereby the distribution is effected. The piston, K_1, first opens the longer ports, *Ca*, and allows the still compressed products of combustion to escape. As soon as the pressure of the latter has sunk to that of the atmosphere the piston, K_2, opens the ports, *Cl*, through which pure air enters the cylinder and sweeps out the waste gases. Hereupon the piston, K_2, opens the ports, *Cg*, allowing gas to enter the cylinder and mix with the air likewise streaming in, whereby the explosive mixture required for a new working stroke is formed. This mixture is compressed during the return strokes of the two pistons and on the cranks reaching their inner dead points it is fired by means of two magneto igniters. Thus a working stroke is obtained for every revolution of the crank-shaft.

The so-called charging spaces, *Rl* and *Rg*, for air and gas, respectively, are refilled during the compression and working strokes by means of a charging pump, *L*, located behind the cylinder, so that at the beginning of the stroke there is always a fresh charge under a low pressure (about 4 to 6 lbs. per sq. in.) ready to enter the cylinder.

In order to prevent gas from entering the exhaust ports the motor is so constructed that whilst air can enter the charging space for gas, no gas can enter the charging space for air. Furthermore, the dimensions of the cylinder are such that for the development of maximum power it is filled at most to about 70 per cent of its full capacity with the explosive mixture. The front piston acts direct upon the middle crank-pin of the three-throw crank-shaft while the rear piston acts upon the two outside crank-pins by means of a cross-piece and connecting-rods. The working of the engine is so regulated that the quantity of gas admitted, which is always exactly in proportion to the power required at the moment, is just sufficient to furnish an easily explosive mixture in the neighborhood of the igniting devices.

The chief advantages of the Oechelhauser motor are as follows: (1) The diameters of the cylinders are reduced and hence also the forces acting upon the driving parts. For instance, the cylinder of the 1700-1800-h.p. engine is only 1100 millimeters (43.3 inches) in diameter. (2) Owing to the pistons and driving parts moving in opposite directions, it is possible to almost exactly balance the reciprocating masses. (3) The whole power passes through the driving parts exclusively, so that the frame is subjected to no horizontal strain, which is often the case to a large extent with engines with rods working in one direction only, so that heavy foundations and strong holding-down bolts are necessary to secure the engine. A further feature, insuring absolutely safe working and great durability, is that the engine requires no valves. Valves in general, and more particularly those of the exhaust, are always liable to derangement, soon become dirty, bend through heat and thereby fail to keep tight. The only valve employed at all is the small one for starting the motor with compressed air, which, however, the moment the motor is running fairly, is closed and remains out of action. (4) The cylinder can be inspected and cleaned in a very short time. After removal of the short piston-rod which connects the rear piston, K_2, with the crosshead, this piston can be withdrawn at once, when the interior of the cylinder as far as the exhaust ports is entirely exposed for access. (5) The moving parts of the piston cooling apparatus are not removed for cleaning the cylinder, but only those pieces which connect the cooling pipe with the interiors of the pistons. All the parts are so arranged that withdrawal of the pistons is in nowise obstructed, while the stuffing boxes of the cooling pipes can be inspected and put in order during running. As the cylinder is open at both ends, there are no covers and no stuffing boxes to remove before cleaning is commenced. If it is desired to withdraw the front piston also, this can be done in the same manner as just described. (6) The combustion chamber is of very practical shape. It is a smooth cylinder without any projections and having no clearance spaces in which dirt might accumulate or waste gases of high temperature remain.

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* Written for the St. Louis Exposition authorities, and published here for the first time by the courtesy of the Department of Machinery.

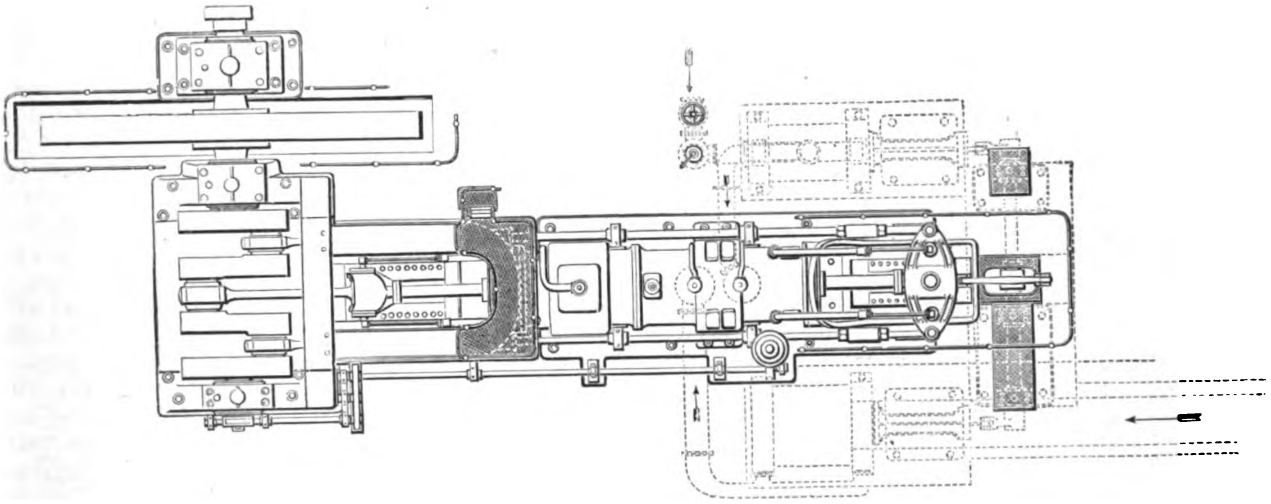


FIG. 3.—PLAN VIEW OF AN OECHELHAUSER GAS ENGINE.

The engine is fitted throughout with self-acting sight-feed lubricators. The standard sizes of the Oechelhauser engine are as follows:

Single cylinder.	Two-cylinder.	R.p.m.
250 h.p.	500 h.p.	150
300 h.p.	600 h.p.	150
400 h.p.	800 h.p.	150
500 h.p.	1000 h.p.	125
750 h.p.	1500 h.p.	125
1000 h.p.	2000 h.p.	94—100—107
1500 h.p.	3000 h.p.	94—100—107

The figures 94 and 107 in the third column refer to the driving of three-phase alternators.

The above figures express the nominal powers of the motors in brake horse-power; they may be overloaded 10 per cent in regular working, and will stand a temporary overload of 20 per cent above these figures. The 500-h.p. single-cylinder motor for instance has furnished as much as 700 horse-power when worked with blast-furnace gas containing less than 900 calories per cubic meter.

The engine is started by means of compressed air. A compressor coupled with an electric or gas motor supplies compressed air under a pressure of 20 atmospheres to a vessel communicating with the engine cylinder through a valve controlled by the engine itself. As soon as the first ignition has taken place the starting valve is closed and the gear disengaged by the attendant.

In order to remove the doubt still expressed by certain engineers as to the durability of the three-throw crank-shaft, I requested Professor E. Meyer, of Charlottenburg, to give an expert opinion on such a shaft. In his report, Professor Meyer first described the manner of calculation advocated by Mr. Max Ensslin, gave the results, and in conclusion stated: "My investigation shows that the crank-shaft made of Siemens-Martin steel, if carefully manufactured so that it may be considered as consisting of a solid piece, will satisfy all demands as to strength and resistance to deformation."

PRIME MOVERS AND ELECTRIC GENERATORS AT THE ST. LOUIS EXPOSITION.

From present indications it would appear that in the disposition of the exhibits of power converting and distributing machinery at the St. Louis Exposition the policy of those in charge of that part of the work will differ greatly from the plan which has hitherto been generally followed. Instead of placing exhibits of electrical machinery (in operation) in the Electricity Building, all such exhibits will be located in Machinery Hall where steam engines and other prime movers will be displayed, as usual. While this disposition of electric generators and motors will doubtless seem strange to those accustomed to find these machines amongst the electrical exhibits, the arrangement is really logical, and has the merit of avoiding the overshadowing of the smaller and purely electrical apparatus in Electricity Building by huge exhibits of large machinery.

The Machinery Building, with its annex, covers 12 acres of ground and is already completed externally. Foundations for the huge engines and other machinery are now being completed. A 40-ton electric traveling crane is installed and is already in use for hoisting huge foundation castings of engines into place, and a 60-ton crane is in course of erection. The eastern half of this building will be devoted to exhibits of machinery and tools, most of which will be shown in complete operation. In general the southern half of the east section will be devoted to wood-working machinery, and the northern half to metal working machinery. Power for all operating machinery will be furnished by motors attached direct to the machines. These motors receive current from generators driven by the engines in the power plant proper in the western half of the building. There will be no line shafts in the entire building, nor anywhere on the grounds.

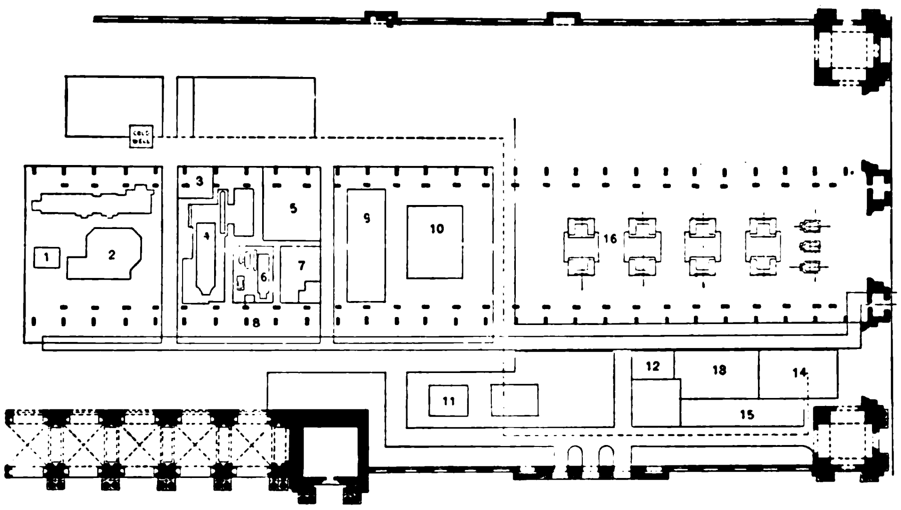
The western half of Machinery Hall will contain probably the largest and most noteworthy exhibition of engines and generators ever brought together in one place. The larger engines are grouped in a row in the center with a line of smaller steam engines, generators and transformers along the northern wall, and internal combustion engines and water motors along the southern wall. The ground plan of this section is shown in Fig. 1; Fig. 2 is a map of the Exposition grounds.

The central bay of Machinery Hall is divided into four sections, the first of which, approaching from the east, will contain an Allis-Chalmers 5000-h.p. Manhattan type engine, with a 3500-kw. Bullock generator. The next section comprises the power plant of the Intramural railway. The third section contains the two greatest exhibits in engineering on the grounds—namely, a 3000-h.p. Cockerill gas engine and an 8000-h.p. Curtis steam turbine. The fourth section contains four 3000-h.p. Westinghouse engines, with two Westinghouse 2000-kw. generators and two of the same capacity made by the General Electric Company.

In the bay south of the Westinghouse engines will be shown among others the following: A 2250-h.p. vertical Hamilton Corliss engine, driving a 1500-kw. generator of the National Electric Company; a steam turbine driving a 1000-kw. Bullock generator; a 1000-h.p. Willans engine exhibited by the Bradley Manufacturing Company with 750-kw. Stanley generators; a 1000-h.p. Mülhausen engine with a 700-kw. generator; a 1500-h.p. Belleville-Delaunay engine driving a 1100-kw. generator.

One of the most noteworthy exhibits in the whole exposition is the 3000-h.p. gas engine built by Société Anonyme John Cockerill, Seraing, Belgium. This engine is of the double-acting tandem type, and will drive a 2000-kw. General Electric generator. This engine is referred to more in detail in an article elsewhere in this issue. Gas for this engine is produced in the Steam, Gas and Fuels Building several hundred feet away, by a producer gas plant made and installed by W. F. Mason & Co., of Manchester, England. The 2000-kw. General Electric alternator driven by the Cockerill engine will operate in parallel with three alternators of the same rating installed by the same company. Another noteworthy gas engine, the Borsig, is referred to further along in connection with the Intramural plant, of which it forms a part.

The largest steam turbine ever put on exhibition will be located next to the Cock-



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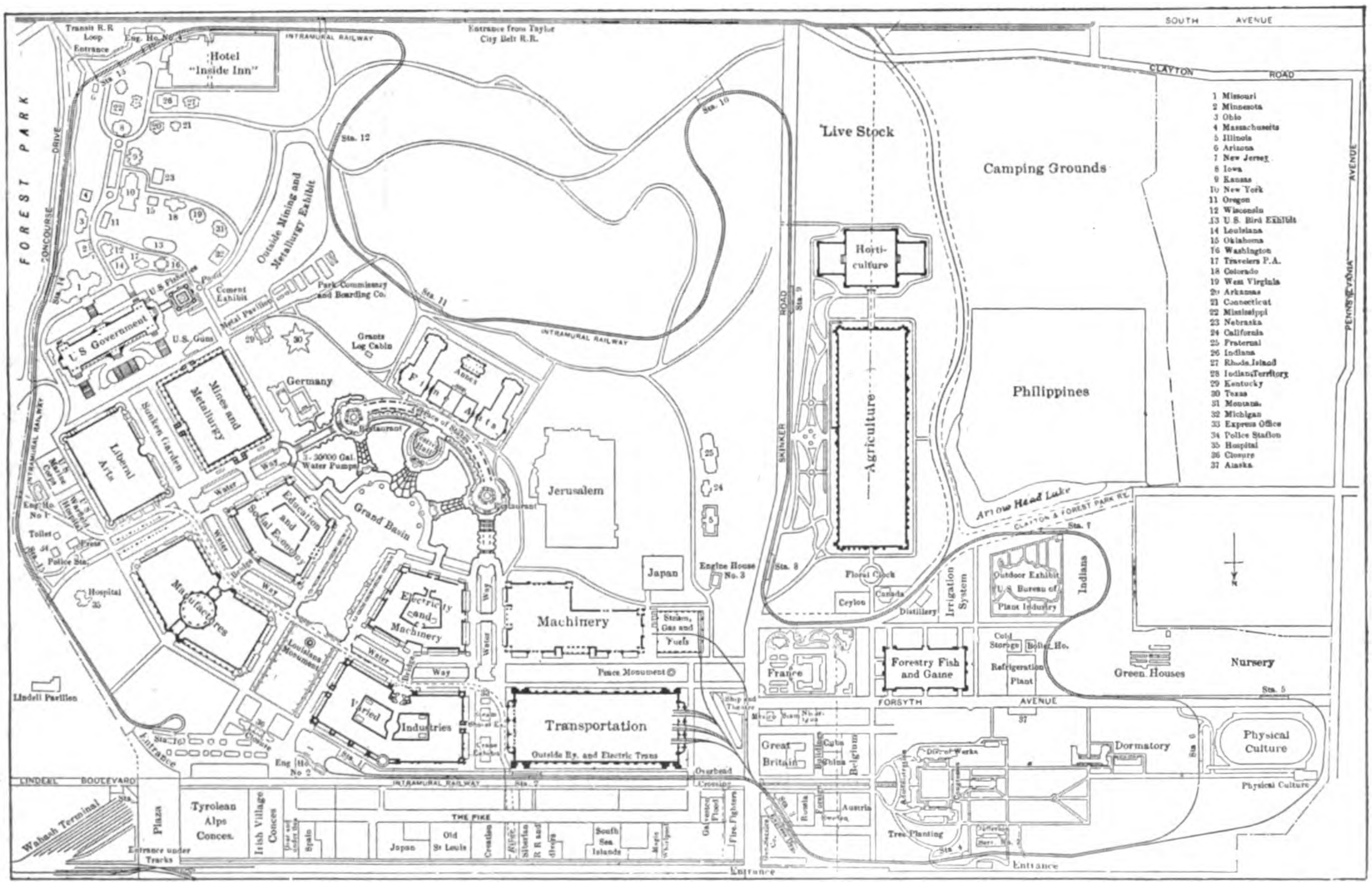
1. Ide 300 horse-power engine, with Bullock 200-kw. generator.
2. Allis-Chalmers 5000 horse-power engine, with Bullock 3500-kw. generator.
3. Abner Doble 500 horse-power tangential water wheel.
4. Borsig 1750 horse-power gas engine, with 900-kw. generator.
5. Murray 750-h.p. engine with 500-kw. generator.
6. Lane & Bodley 900 horse-power engine, with 600-kw. generator.
8. Intramural power plant, Crocker-Wheeler generators.
9. Cockerill 3000 horse-power gas engine, with 2000-kw. General Electric generator.
10. General Electric 8000 horse-power steam turbine, with 2000-kw. generator.
11. Hamilton-Corliss 2250 horse-power vertical engine, with 150-kw. National Electric generator, and 1000 horse-power steam turbine, with 1000-kw. Bullock generator.
12. Bradley Mfg. Company Willans 1000 horse-power engine, with 750-kw. Stanley generator.
13. Mulhausen 1000 horse-power engine, with 1100-kw. generator.
14. Belleville-Delaunay 1500 horse-power engine, with 1100-kw. generator.
15. Transformers.
16. Four Westinghouse 3000 horse-power engines, with two Westinghouse 2200-kw. generators and two General Electric 2000-kw. generators.

FIG. I.—GROUND PLAN OF ENGINE SECTION OF MACHINERY HALL.



SOUTH AVENUE
CLAYTON ROAD
PENNSYLVANIA AVENUE
FOREST PARK
CONCOURSE DRIVE
Transit R.R. Loop Entrance
Eng. Ho. No. 4
Hotel "Inside Inn"
INTRAMURAL RAILWAY
Entrance from Taylor City Belt R.R.
Live Stock
Camping Grounds
Outside Mining and Metallurgy Exhibit
Horticulture
Park Commissary and Boarding Co.
Grants Log Cabin
U.S. Government
U.S. Fisheries
U.S. Guns
Cement Exhibit
Metal Pavilion
Germany
Mines and Metallurgy
Fine Arts
Liberal Arts
Sunken Garden
Education
Social Economy
Grand Basin
Jerusalem
Agriculture
Philippines
Arrow Head Lake
Hospital
Police Sta.
Machinery
Electricity and Machinery
Japan
Engine House No. 3
Floral Clock
Ceylon
Canada
Distillery
Irrigation System
Outdoor Exhibit U.S. Bureau of Plant Industry
Indiana
Steam, Gas and Fuels
Peace Monument
Forestry Fish and Game
France
Cold Storage
Refrigeration Plant
Green Houses
Nursery
FORSYTH AVENUE
Varied Industries
Transportation
Outside Ry. and Electric Trans.
Great Britain
Cuba
China
Belgium
Dormatory
Physical Culture
Lindell Pavilion
LINDELL BOULEVARD
Wabash Terminal
Entrance under Tracks
Plaza
Tyrolean Alps Concess.
Irish Village
THE PIKE
Japan
Old St Louis
South Sea Islands
Tree Planting
Austria
Entrance
1 Missouri
2 Minnesota
3 Ohio
4 Massachusetts
5 Illinois
6 Arizona
7 New Jersey
8 Iowa
9 Kansas
10 New York
11 Oregon
12 Wisconsin
13 U.S. Bird Exhibit
14 Louisiana
15 Oklahoma
16 Washington
17 Travelers P.A.
18 Colorado
19 West Virginia
20 Arkansas
21 Connecticut
22 Mississippi
23 Nebraska
24 California
25 Fraternal
26 Indiana
27 Rhode Island
28 Indian Territory
29 Kentucky
30 Texas
31 Montana
32 Michigan
33 Express Office
34 Police Station
35 Hospital
36 Closure
37 Alaska
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FIG. 2.—MAP OF ST. LOUIS EXPOSITION GROUNDS.

erill gas engine. This is the Curtis turbine mentioned before. It will be rated at 8000 horse-power, and is being built by the General Electric Company. It is built on the same plans and specifications as the ten turbines being constructed by the same works for the Commonwealth Electric Company, of Chicago, and the eight turbines for the New York Central Railroad's New York power house. While its rating is nominally 8000 horse-power, it is guaranteed to deliver 12,000 horse-power with safety.

The length of the Intramural electric railway is approximately 10 miles. The power plant for this railway occupies a space approximately 100 feet square in the Machinery Building, and comprises the following engines and generators: A 1750-h.p. Borsig gas engine (described on page 6 of this issue) direct connected to a 900-kw. generator; a 900-h.p. Lane & Bodley steam engine direct connected to a 600-kw. generator; a 750-h.p. Murray Iron Works engine coupled to a 500-kw. generator, and a 600-h.p. Harrisburg engine coupled to a 400-kw. generator. All of the generators are of Crocker-Wheeler manufacture. The plant also includes a 500-h.p. Abner Doble tangential water-wheel driving a Crocker-Wheeler generator. This wheel will be operated by water forced through the delivery pipes by artificial pressure, of course, the pressure at the nozzle to be 300 lbs. per square inch. The wheel will run at 900 r.p.m.

What the Corliss engine was to the Centennial Exposition of 1876, the Allis-Chalmers Manhattan type of steam engine will be to the St. Louis Exposition. While the Curtis steam turbine exceeds it in power, the Allis-Chalmers engine will be the largest piston prime mover on the grounds. Its rating is 5000 horse-power, and it is known as the Manhattan type because it is built on the lines of the engine furnished by the same builders for the Manhattan Railway system of New York. It occupies a floor space 35 by 45 feet, and is 54 feet high, of which 34 feet will be above the floor. Its weight, with the Bullock generator which is coupled to it, is over 600 tons. The foundations for this engine are now about completed. The generator field magnet is, of course, mounted on the main shaft of the engine, and will run at 85 revolutions per minute. A 300-h.p. Ide engine with a 200-kw. Bullock generator will be located in the same bay with the Allis-Chalmers engine.

Altogether, over 45,000 horse-power is represented in the engines which will be in operation in the western end of Machinery Hall, of which 1200 horse-power will be required for electric lighting, 6000 horse-power for the Cascade pumping station and the balance for exhibits and general purposes. Steam for the engine and turbines comes to Machinery Hall through a huge underground steam pipe from the boilers in the Steam, Gas and Fuels Building, which adjoins Machinery Hall to the west.

The Steam, Gas and Fuels Building is almost in the geographical center of the grounds. It is built of steel and cement, and covers a space 300 by 326 feet; it is about 100 feet high. In it will be grouped the best known types of boilers, both European and American. The pressures will range from 125 to 300 pounds per square inch. The building will also contain gas producing plants for supplying the gas engines in Machinery Hall, and briquetting plants, water purifying and softening systems for the water supply and mechanical draft plants for supplying the boiler furnaces.

The southwestern quarter of the building will be devoted to the gas producers, the largest unit being the 3000-horse-power Duff-Whitfield system installed by W. F. Mason & Co., of Manchester, England. Adjoining this will be a 2000 horse-power plant installed by R. D. Wood & Co., of Philadelphia. Both these systems will deliver their gas into tanks or holders. A noteworthy gas producer is that of Julius Pintsch, of Berlin, of 2400 horse-power capacity, which requires no receivers or reservoirs. The Société Anonyme John Cockerill will exhibit a gas scrubber.

The pumping plant of the Cascade is situated underneath the easternmost or left-hand spillway. It consists of three Worthington centrifugal pumps, each of which will deliver 30,000 gallons of water per minute against a double head of 159 feet. These are said to be the largest individual pumps ever built. They are 36-inch. single stage and each is to be driven by a 2000 horse-power alternating-current motor. The water before being pumped will be subjected to filtering and purifying processes and will be used over and over again with only a sufficient additional intake through the purifiers to compensate for leakage and evaporation. A unique feature of this Cascade is that it is to be made useful as well as ornamental. It is to serve as a cooling tower for the steam plants in the Machinery Building and its annex, 3000 feet away. The exhaust steam from the engines, after being condensed, will be pumped through a line of piping to the Cascade pumping plant, and after dashing down the Cascade and passing a mile or two around the grand canal the water will be pumped from a low point in the canal near Machinery Hall westwardly to the boiler feed-water heaters in the power plant. The piping for the Cascade is both spiral riveted and the ordinary construction.

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Utilization of Waste Gas.—Henry G. Morris, in a paper on the gaseous fuel problem read before the Engineers' Club of Philadelphia, says, "the rapidly increasing use of gas engines of high powers is an evidence of the desirability from an economical standpoint of the use of gaseous fuel, opening up a wide field of problems which the engineer will be called upon to solve in the near future. As an example, it is probable that fully 20,000 tons of coke is made per day in the Beehive Ovens, within a short distance of the line of the Pennsylvania Railroad between Altoona and Pittsburg, from which about 100,000,000 cubic feet of gas is discharged into the air or wasted, which if converted into power through gas engines would represent 5,000,000 horse-power-hours, or the effort of about 104 gas engines of 2000 horse-power each."

TELEPHONE ENGINEERING.

Erection of Messenger.

BY F. J. DOMMERQUE.

Before attempting to pull any messenger up on a pole line, the entire line must be firmly anchored and guyed. The methods of anchoring and guying will be discussed later. Also messenger supports must be provided upon the pole by which the messengers are to be held. The designs of such supports are various. The one shown in Fig. 1 is much used for messenger wire and very small strand; for $^{5}/_{16}$-in. strand and larger sizes, the so-called L bracket, illustrated in Fig. 2, is favored. The bracket consists of two parts, one of which is attached to the pole by one bolt and one lag screw or by two lag screws, and the other clamps the strand by two ⅜-in. bolts. The clamp shown in Fig. 1 needs only one lag screw to clamp the messenger and hold the support to the pole. For two cables on one pole, two of the described supports can be used, one on each side of the pole.

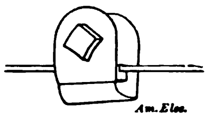

FIG. 1.

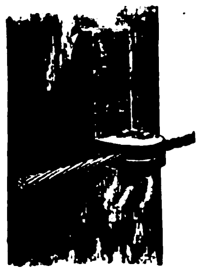

FIG. 2.

For more than two cables on a pole it is customary to use an angle-iron cross-arm attached to the pole in or below the lowest gain. The angle-iron arm is usually arranged for four cables, as that is the limit for aerial cable construction in all cases; in fact, that is hardly ever reached. The angle itself is of 4-in. x 3-in. stock and 32 inches long. It is drilled as shown in Fig. 3 for two cross-arm braces, which are in this case attached to the pole above the arm. The distance of 16 inches between the two cables nearest to the pole may be made greater when it is desirable to allow more space for a lineman to pass in climbing the pole. In some cases where the strain is very severe, a strap is put around the pole in addition, as shown in Fig. 4. Figs. 3 and 4

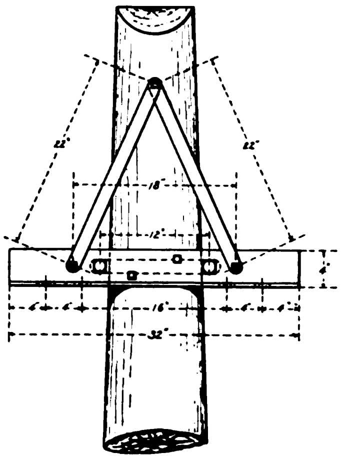

FIG. 3.—ANGLE-IRON CROSS-ARM.

show the holes supplied for the bolts that hold the messenger. These holes are either square or round. When ¼-in. carriage bolts are used to hold the messenger, the holes are cut square to fit the square heads of the bolts. When U-shaped clamps are used, such as that illustrated in Fig. 5, the holes are round, 9/16 inch in diameter. In both cases the strand is clamped between the angle and a strap held by two nuts. On places where heavy strains are encountered, two angles may be placed back to back. In this case the other angle would take the place of the strap in Fig. 4, and would be provided with bolts the same as the first arm for holding the messengers.

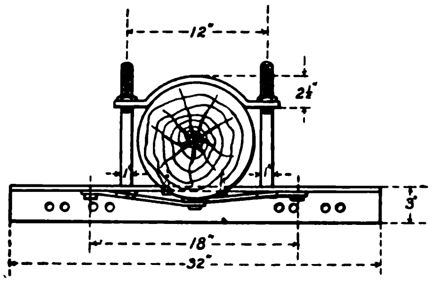

FIG. 4.—ANGLE-IRON CROSS-ARM.

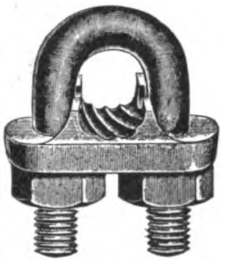

FIG. 5.—CLAMP.

The messenger is lifted up to the poles like ordinary wire and clamped to the supports temporarily but tightly. The terminal of the messenger must be fastened securely to an anchor pole. It is better not to start the messenger from the same pole that the cable starts from, but from the pole ahead, so as to leave the cable pole free from anchors. It is advisable not to use the beginning of the messenger as a guy, but to terminate the messenger on the anchor pole and to use a separate guy for anchoring. The end of the messenger should be wrapped three times around the pole and then brought back so as to form an eye at least eight inches long, and then it should be clamped to the strand with two strand clamps, each clamp consisting of a U-shaped piece and a strap, or of two parts which are clamped together by two or three ⅜-in. bolts. Such clamps are illustrated in Figs. 6 and 7. To prevent the messenger from cutting into the pole, a row of galvanized iron strips 1 inch wide and 6 to 8 inches long are preferably set vertically around the pole with about an inch space between them, the messenger being prevented from slipping off these strips by a spike driven into the pole. The strips are nailed to the pole before the strand is wrapped around them. When more than one messenger terminates upon the same pole, they are fastened one above the other.

After the messengers are firmly secured to the starting pole, the tackle for tightening them is attached at the end of the messenger; one messenger is tightened at a time. If this is done by hand three pairs of pulley blocks are needed, the first one fastened to the pole at which the messenger is to terminate, the second one fastened to the next pole in line, and the third one fastened to a stub or bar some distance farther out, as shown in Fig. 8. The first pair of blocks is attached to the pole at the same level with the messenger supports, and is provided at its free end with a clamp to grip the messenger. With this pair a ¾-in. rope is used about 200 feet long. The men first pull the messenger tight with this pair, after the support clamps have been loosened to allow the messenger to slide freely. When they have pulled it as tight as they can, the messenger is cut off leaving the end long enough to go three times around the pole and form a long eye. Then the end of the pulley rope is fastened to the second pair of pulley blocks, which is attached to the next pole about midway between the ground level and the level of the messenger supports, and which is provided with a ¾-in. rope about 100 feet long. The messenger is pulled as tight as it will go with this second pair, and finally the third pair is brought into action. This pair needs only a ⅝-in. rope about 100 feet long. With this pair the messenger is pulled until it has the proper deflection. Then all supports are tightened again, this time permanently, and the messenger is wrapped three times around the pole and fastened by two strand clamps, the same as at the beginning.

The pole on which this messenger terminates is preferably the next behind the one upon which the cable terminates. In cases where another cable starts upon a pole only a few poles further along, and the messenger for the first cable is short enough to leave a sufficient length for the second cable, it is advisable not to cut the messenger but to run it right through to the end of the next cable.

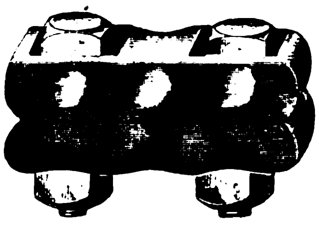

FIG. 6.—GUY CLAMP.

If more than one messenger is to be tightened, the first one is pulled up and clamped down, but not fastened to the end pole. The other messengers are then pulled tight in the same manner as the first one. When the second one has been pulled tight, it will be noticed that the first one has become slack again on account of the line yielding to some extent to the additional pull. This slack has to be taken up, and then the first cable can be secured permanently. The others are then pulled up to the same deflection as the first one, and permanently fastened. It is possible to pull a messenger around a smooth curve, but not around a corner. In the latter case the messenger must be cut and the two ends fastened to the corner pole. When a capstan is used to pull a messenger tight, only one set of pulley blocks is required.

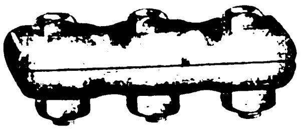

FIG. 7.—GUY CLAMP.

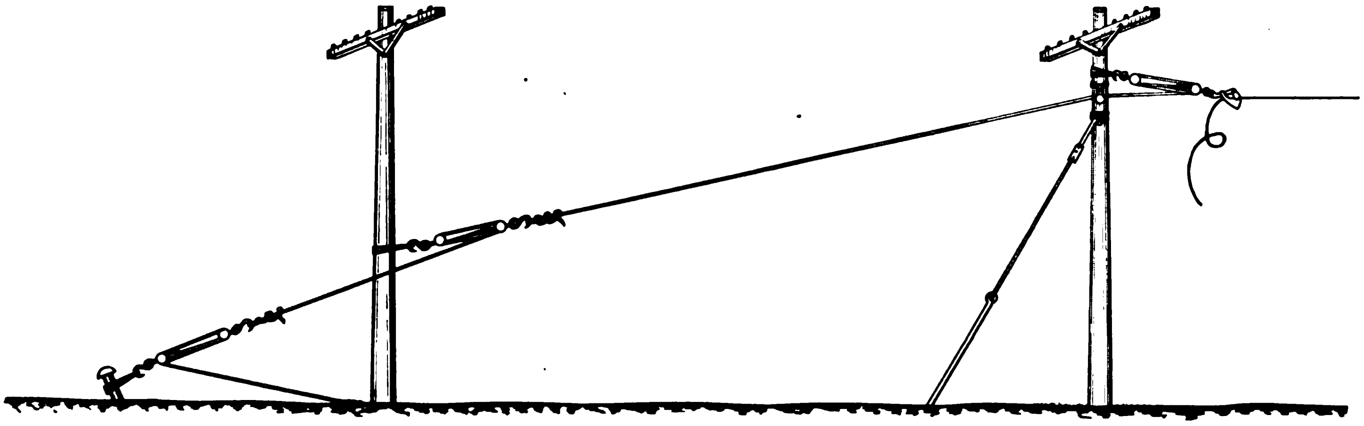

FIG. 8.—METHOD OF TIGHTENING MESSENGER WIRE.

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Heating Value of Acetylene and Coal Gas—The heat units developed per cubic foot of acetylene and coal gas are 1850 and 630, respectively. One quart of water was brought to boiling from 50° Fahr. in 8½ minutes with acetylene and in 10½ minutes with coal gas; the burner of the former consuming two cubic feet of gas per hour, while that of the latter consumed 16 cubic feet per hour.

THE EFFICIENCY OF MODERN TELEPHONE EQUIPMENT.

BY M. A. EDSON.

The engineering problems of the transmission of speech have for the last twenty years occupied the time and inventive genius of a large number of engineers and involved an enormous financial expenditure, not only in actual construction, but in some purely experimental exchanges involving every actual condition to be met in operation and maintenance. After all, there are instances where exchanges planned with every feature carefully worked out on a basis of 10 years' service have been radically changed at large expense before being put in operation, on account of some engineering or operative improvement.

After reviewing all these changes and evolutions can it be said that the actual efficiency of the plant for purely conversational purposes, after the desired connection has been made, is any higher to-day than it was twenty years ago? The answer may be made in several ways. A general statement is that the local transmission is only a little better, but the long-distance transmission is greatly improved, not in any one part particularly but as a whole.

The increase in the efficiency of a long-distance telephonic transmission system is 50 per cent in the line and 20 per cent in the transmitter. Conversation may be carried on over these improved lines with a Blake transmitter with good results, but it lacks power and clearness, due to several faulty elements in the mechanism for transforming the energy of the sound waves into electrical undulations. This mechanism has been one on which more work has been done in proportion to the results than any other part of the plant. It is true that there is today the all-carbon transmitter with the low-wound induction coil. This transforms the sound energy into electrical undulations of better form for transmission; that is, the wave form is better, conforming to the sound waves and avoiding the sharp peaks due to the reactance of a high-wound secondary and the undamped inertia of the transmitter parts.

The principal inefficiency in the modern transmitter has two elements: The loss in the mechanical transformation of sound energy into mechanical pressure on the carbon and the loss due to maintaining a supply of electrical energy which is varied between the rather narrow limits of one-tenth to fifteen-hundredths of an ampere as an average for common battery and one-tenth to four-tenths of an ampere for local battery systems. The exact measurement of sound energy at a point six inches from the mouthpiece of the instrument has been tried, but the results are not uniform, and most of the methods are open to serious errors introduced by the direct action of the air pressure on the instruments. The use of vibrating strings has so far proved the most satisfactory, but is open to the objection that two very heavy piers are necessary in order that the vibrations may not reach the measuring diaphragms by mechanical conduction. These strings in the recent experiments have been piano strings on separate mountings electrically maintained by a fine platinum wire at a nodal point dipping into mercury, the wire at this point vibrating between the poles of a powerful permanent magnet.

In this connection a frequency of 125 to 750 cycles per second should be used and the most common constant is 750, but when the frequency is raised to 1200 some phenomena develop in the iron which would seriously interfere with transmission efficiency if they occurred at a lower frequency. Fortunately there are only a few singers that can reach a note as high as 1100 and experiments made at these frequencies (750 to 1200) are more interesting than useful.

Th general tendency of late years is toward the use of transmitters having a low fundamental note, as such transmitters will give greater volume and rate of variation of the primary current per unit of sound energy; lower fundamentals also lessen the tendency of the transmitter to amplify certain tones which are near that of the diaphragm. The efficiency of the subscriber's station equipment from an engineering point presents more difficulty than that of the central office if exact measurements are to be made, but from recent tests the transmitter changes sound energy into electrical undulations at an efficiency of 50 per cent in common battery plants and 75 per cent in local battery. In common battery work the efficiency is still further reduced if the loss in the line is considered, which should be the case as it is a part of the primary circuit. These figures are only for the transmitter, and do not include the induction coil or other inductive devices.

Another uncertain element in the efficiency of the common battery transmitter is the distance from the exchange. It is evident that greater distance from the exchange means less current, as it is not the modern practice to vary the battery or conductor resistance for different lengths of line. The consequence is that an instrument in the exchange building may receive three-tenths of an ampere through the transmitter while another receives one-hundredth of an ampere through four miles of cable, which is about as far as it is safe to go without repeating coils and trunk lines. The average limit is usually set at 350 ohms per line for 24 and 40-volt systems. The line efficiency at two miles from the exchange is 80 per cent, and may go as high as 90 per cent for common battery systems, but for local battery the line is used only for the high voltage variable telephone current and the efficiency is higher. The average value is 95 per cent for aerial copper metallic circuits and 85 per cent for standard underground cable.

In relation to the receiver very little improvement has been made in the original arrangement of a permanent magnet and diaphragm, with a soft iron cored pair of electromagnets, but any improvement that may be made will not materially affect the efficiency, which is about 85 per cent. Receivers, like transmitters, should be made for frequencies of about 750. The most efficient instrument should have a range of 250 to 2000. The acoustic properties of the receiver may be improved in several ways, principally in the shape of the cavities around the diaphragm. The efficiency of the exchange proper can be considered as a means for connecting the subscribers together in pairs, and the efficiency not only depends on the speed with which the connections are made but the cost and accuracy of operation.

The engineering elements which enter into the construction of a modern telephone exchange may be divided into three elements :(1) the power plant, (2) the switching mechanism proper and the distributing and testing boards, (3) the various toll, trouble and supervising desks.

From test runs on five common battery exchanges of 1000 to 5000 lines equipment the mean of all tests shows a power-plant efficiency from the supply mains to the various switchboard distributing points of 50 per cent. This is distributed as follows: Motor-generator combination, 67.5 per cent; charging mains, 94.3 per cent; motor-generator and battery leads, 63.5 per cent, and batteries, 72 per cent. The percentage of total energy delivered to the switchboards, therefore, averaged 52 per cent. The ringing dynamotors have a 24-hour efficiency of 40 per cent, operated with lamps in the ringing circuits.

Results obtained in a recent test of protection devices showed that 98 per cent of the spools were properly protected and 2 per cent injured by charging, but the latter would not have caused a fire; the general efficiency of the protection and distributing boards was 95 per cent. The toll desks or switchboards are generally equipped with the least apparatus so as to interfere as little as possible with transmission. In the average modern toll board, the equipment is only about the same as the system under which the main exchange is installed, except in the case of the automatic system and then it becomes a separate element and its efficiency may be low in comparison. Trouble desks are of a special nature, and are not subjected to the same demands as an exchange equipment. They may be considered a separate element. The supervisory desks are also treated as a separate element, but their efficiency is to be combined with the switching element proper as their work as a connective source increases the general efficiency of the system.

In considering the efficiency of the switching element proper, we may go back to the subscribers' station and lay down the requirements for a connection. These are: (1) Good transmission, by which is not meant great loudness, but strong, clear conversation, entirely free from annoyances, such as clicks, cross talk, inductive disturbances, and other people or operators cutting in on the line; in other words, the *equipment must talk and nothing else.* (2) Speed in getting the other subscriber. This must be attained without a sacrifice of accuracy, and the only delay must rest with the called subscriber. (3) After the conversation is finished, no time of either subscriber, calling or called, should be taken up with manipulating the equipment; it should absolutely be self-restoring. (4) The equipment must be economical of power and expensive supplies, low in mechanical maintenance and long-lived as to the most-used parts. The item of first cost is not entered into in this discussion as the problem is viewed more from the engineering standpoint without regard to first cost.

Under the first requirement the efficiency will be, we will assume, 100 per cent between two subscribers with no exchange and local battery. To compare this with a 5000-line exchange on the central energy manual switchboard and starting at the terminals of the battery, the first piece of apparatus is the retardation coils; since these coils are a necessary part of all large common battery systems, it only remains to determine the most efficient arrangement. In the first arrangement, the coils are both retardation and repeating coils, and in the same circuit is included disconnecting relays as a separate element, also lamps. In the second, the retardation coils, resistance and disconnect relay are one, with the addition of condensers between the coils in the well known way. The efficiency of the first combination is 40 per cent; that of the second combination is 50 per cent, as it is less influenced by leakage and contains the signaling element in one combination; the use of condensers is also an advantage in reducing the inductive losses in the coils. In the exchange with local battery only, a high impedance and high resistance bridge is across the circuit, and the transmission efficiency is 95 per cent after all connections are made. This refers only to speed transmission and the best switchboard construction for local battery, electromechanical signal call and disconnect magneto signaling systems not being included in this discussion as they are obsolete for large exchanges. In the first combination, the repeating coil system is inefficient for the reason that it is very susceptible to unbalanced conditions of lines and leakages and the difficulty of constructing coils which will have a high efficiency under such load variation as 0.3 ampere to 0.01 ampere; also because of the loss in the auxiliary relays, lamps and similar devices. Second requirement: Speed in getting the called subscriber. It is generally conceded that the best types of modern central energy manual switchboards require the same number of operations for large exchanges. The operations may be enumerated thus: 1, subscriber takes the receiver off the hook; 2, subscriber's individual signal lights up above the pilot lamp, involving a double operation, as the relay must first make the contact and the lamp filament must then be located; 3, operator inserts answering plug, which involves three movements from a military point of view, *i.e.*, pick up plug, locate jack, insert plug; 4, operator sets listening key; 5, operator asks number; 6, subscriber gives number; 7, operator repeats number; 8, operator picks up plug and locates jack in multiple; 9, operator test for busy; 10, operator inserts plug; 11, operator rings called subscriber; 12, operator restores listening key; 13, operator notes when called subscriber's lamp goes out in cord circuit; 14, called subscriber answers; 15, called subscriber hangs up receiver; 16, connecting cord lamp lights; 17, calling subscriber hangs up receiver; 18, operator removes answering plug; 19, operator removes calling plug.

If trunking is necessary, the following sequence must be substituted for the last twelve operations: 8, operator selects order wire key; 9, operator gives order to incoming trunk operator; 10, incoming trunk operator repeats number; 11, incoming trunk operator gives trunk number; 12, first operator picks up plug, locates trunk jack and inserts plug; 13, incoming trunk operator tests line of called subscriber for busy; 14, incoming trunk operator inserts incoming trunk plug in called subscriber's jack; 15, incoming trunk operator sets automatic ringing key; 16, automatic key rings subscriber; 17, called subscriber takes up receiver and restores key automatically; 18, calling subscriber hangs up receiver; 19, supervisory lamp at first operator's position lights up; 20, called subscriber hangs up receiver; 21, second supervisory lamp lights up; 22, first operator pulls out plugs; 23, disconnect lamp on incoming trunk cord lights up; 24, incoming trunk operator pulls out trunk plug.

In all manual boards there is very little variation in this cycle of operations. Visual mechanical signals are used instead of relays and lamps, and different methods of trunk operation are devised without materially increasing the efficiency. The efficiency of operators as a part of the system is one of the most variable quantities with which we have to deal in the manual system; one operator may work eight hours at an efficiency of 80 per cent. This is based on the principle that the operator has 100 per cent of work to perform, and 80 per cent of the work is done correctly and 20 per cent is unnecessary errors and delays. As a result of numerous tests on modern common battery equipment, a general efficiency of 75 per cent was obtained.

The third requirement, the disconnection of all apparatus, is performed in a way to leave little to be desired at present, as indicated in the foregoing discussion of the cycle of operations for each call.

Fourth requirement: Power economy and long life of apparatus. The low power cost for a local talking battery central signaling battery switchboard places it at an efficiency in this respect of 75 per cent. This is due to the fact that current is used only when the signals are operated and no cut-off relays used. In the most efficient common battery combination, the retardation coil-relay-condenser system, with visual electro-mechanical signals, consumes less energy in the all-day operation of the equipment; this may reach an efficiency of 60 per cent. The common battery repeating coil-relay system, with lamp signals throughout, works at an average efficiency of 50 per cent. All of these efficiencies refer only to the switching equipment and do not include lines, power plant or subscribers' equipment.

Under the first requirement the operation of an automatic equipment is very efficient, as such a system is free from the interference of operators, busy test clicks, cross talk, and reasonably free from inductive disturbances. The line is bridged by high impedance high resistance coils, and has about the same efficiency as the local battery board with one clearing out drop, but the complexity of the plant must be considered; 90 per cent efficiency is about the average at present. Speed of operation is one of the main features of the system, and will reach 95 per cent of the theoretical requirements.

The establishment of a connection and clearing of the lines are reduced from 19 and 24 operations to from 6 to 9 in calling any number from 1 to 9999; this is divided thus in the automatic exchange: 1, subscriber removes receiver from hook; 2, subscriber rotates dial for thousands; 3, subscriber rotates dial for hundreds; 4, subscriber rotates dial for tens; 5, subscriber rotates dial for units; 6. subscriber pushes ringing button; 7, called subscriber answers; 8, calling subscriber hangs up receiver and thereby clears the line; 9, called subscriber hangs up receiver. If the number is under 10, the second, third and fourth operations are eliminated.

The third requirement of clearing lines is included in the foregoing cycle, as it was in the discussion of manual operation.

The power required is a little less than in the common battery, and the efficiency of the power plant is the same. Maintenance (mechanical) is less than with the common battery system, and the life of the plant is greater, as it can be built on heavy lines from an engineering standpoint, requiring no special refinements in the way of woodwork and finish.

In conclusion, the efficiency of exchange equipments is affected in so many ways that it is difficult to compare one plant with another. The local conditions under which one plant operates may be such that another could not do the work with half the efficiency due to the methods of operating which are necessary to the public service; the all-day efficiency is variable and is modified by the class of service given, whether measured service or flat rate.

The telephone industry has passed through three periods of evolution, the eighties, when the apparatus used included the magneto series and Blake transmitters; the period of the nineties of multiple bridging, granular carbon transmitters, all metallic circuits, etc., and the period of 1900 of central-energy automatic signals and better lines. We are now entering on the fourth period, involving automatic central energy telephony, and with high hopes of increasing the all too small efficiency of the modern telephone equipment.

[The foregoing is an abstract of a paper read last month before the Chicago Electrical Association.]

American Internal Combustion Engines

In view of the remarkable development of the gas engine as to point of magnitude of output per unit and closeness of speed regulation, which has brought this type of prime mover up from the level of a driver of coffee grinders and remote pumping or hoisting outfits to a serious competitor of the Corliss and similar types of steam engine, a presentation of American practice in gas engine construction will doubtless be of interest. And as much serious and notable engineering work has been done on internal combustion engines using oil as fuel, that form of engine has been included in this article.

It is doubtless well known that there are two general methods of securing speed regulation in gas and oil engines, namely, the throttling method and the "hit-and-miss" method. Throttling is used in all engines of large output and practically all engines for driving dynamos, for the reason that it gives a more nearly uniform rate of speed than the "hit-and-miss" method. It usually consists in varying the amount of explosive mixture admitted to the cylinder according to the requirements of the load, exactly as the quantity of admitted steam is varied by the governor of a throttling steam engine, although there are many builders who prefer to throttle the gas or oil supply only, allowing the total quantity of mixture to remain constant. This latter method obviously regulates the power of the engine by regulating the calorific value of the mixture and thereby the force of the explosion, or more scientifically, the initial pressure due to combustion. The throttling of the gas or oil alone has the merit of maintaining constant compression, whereas throttling the whole mixture causes the compression to vary with (not proportionately to) variations in the load. It seems to be the opinion of the majority of gas engine designers, however, that it is better to keep the richness of the mixture unchanged, after adjusting it so as to secure maximum combustion efficiency, and to vary the quantity of mixture admitted, than to vary the quantity of gas or oil and thereby impair the combustion efficiency of the mixture.

The "hit-and-miss" method consists in suspending admission of either the fuel alone or of the mixture of fuel and air when the speed becomes excessive. The governor of an engine of this class will skip a charge every now and then, when the engine is running on less than its full load, the frequency of the "misses" depending, of course, upon the proportion of full load being carried. On very light loads, several admissions will be omitted consecutively; then there will follow a single admission and explosion which "boosts" the speed above normal to such an extent as to cause several admissions to be skipped again, and so on. It is obvious that under such conditions anything near a uniform rate of angular speed is out of the question. At points near full load, however (or the load which will require relatively few misses) the "hit-and-miss" method yields excellent speed regulation, and it has the advantage that the cylinder is occasionally swept out by pure air, if it is the fuel delivery alone which is cut off and not the air and fuel both.

Almost all engines of considerable output are operated on what is commonly termed the "Otto" cycle, and more accurately but less frequently referred to as the "Beau de Rochas" cycle; the cycle was originated by Beau de Rochas, but Otto was probably the first engineer to apply the cycle in a practical manner. The cycle requires four single strokes of the piston; on the first stroke (assumed to start with the piston in the position nearest the cylinder head) the explosive mixture is drawn into the cylinder; then the piston returns, compressing the charge; when it reaches the starting position, the charge is ignited and the expansion of the heated gas forces it forward again; at the outward end of the stroke the exhaust port is opened, and as the piston returns again to its starting position it sweeps out the inert gases produced by the combustion of the charge. Thus the piston traverses the length of its stroke four times in each complete cycle. Engines operating thus are commonly but inaccurately termed "four-cycle" engines; "four-stroke cycle" would obviously be more descriptive.

Many small engines and a few large ones are operated on the two-stroke cycle, and

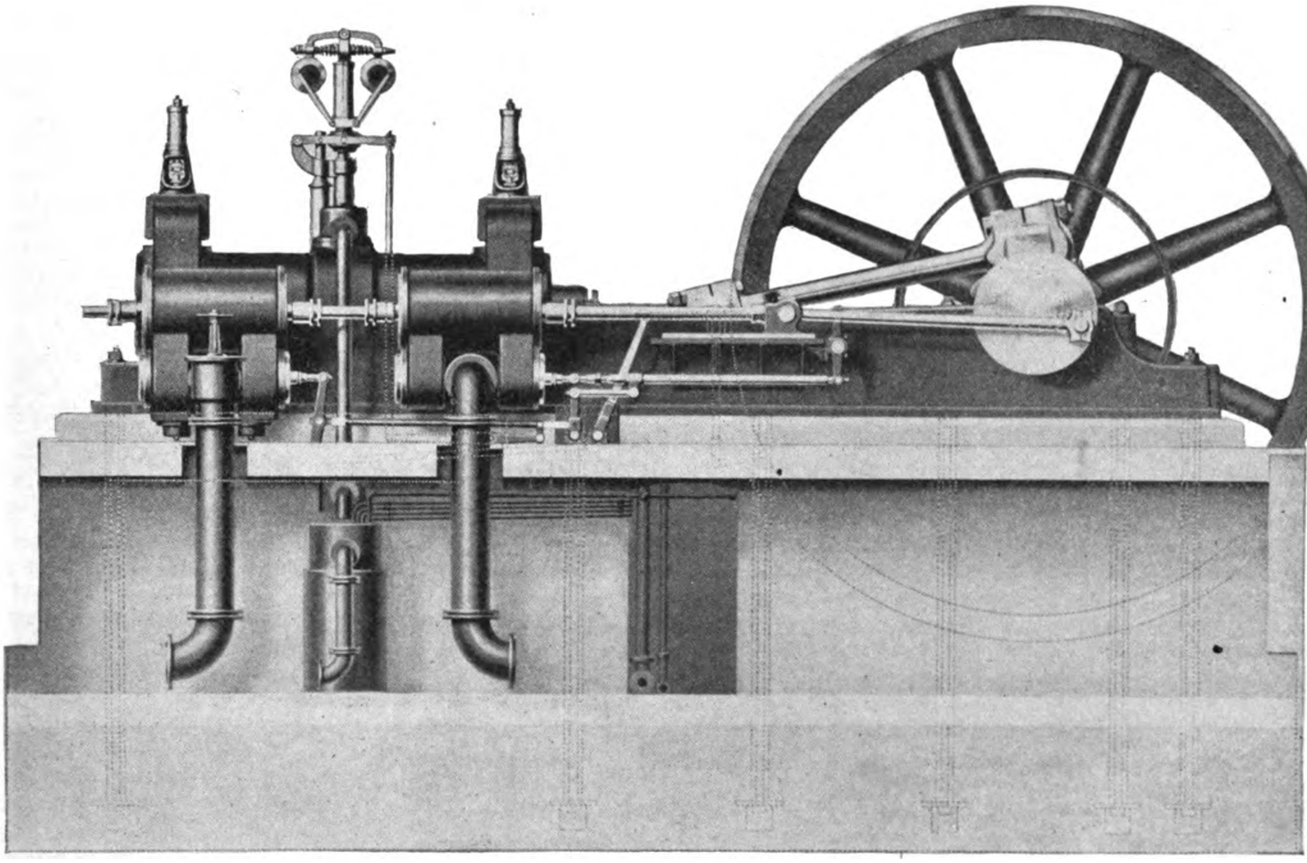

FIG. I.—SIDE ELEVATION OF THE KOERTING DOUBLE-ACTING, TWO-STROKE CYCLE GAS ENGINE.

are known as "two-cycle" engines. In the two-stroke cycle a separate receiving chamber and a pump for drawing in and slightly compressing the charge are necessary; in small machines the engine is always single-acting, and the front of the cylinder is commonly combined with the crank-case to form a receiving chamber, the front side of the piston acting as a pump. The cycle is easier to describe starting from the moment of ignition. The piston, at this moment, is at the "inner" end of its travel, of course, and a charge of the mixture is contained in the cylinder behind it, while another charge has just been drawn into the receiving chamber. As the expanding gases drive the piston forward it compresses the charge in front of it; at the end of the stroke, the exhaust port is opened on one side of the cylinder, and an instant later a port on the other side of the cylinder leading to the receiver chamber is also opened, so that the exhaust gases escape on one side while the fresh charge, which has been slightly compressed, enters on the opposite side of the cylinder; the piston returns, further compressing the charge now behind it, and drawing in another charge into the receiving chamber. This brings the engine back to the beginning of a cycle. The two-stroke cycle is obviously open to the objection that either some of the entering charge must be carried out along with the exhaust gases or else some of the inert gases which should be exhausted must remain in the cylinder and contaminate the fresh charge. In some cases, the exhaust port is opened considerably in advance of the opening of the admission port, and a third port is opened simultaneously to admit pure air under compression, the air serving to sweep out the inert gases and form a barrier between the exhaust port and the incoming fresh charge when the latter is admitted. This practice is observed in the operation of almost all two-stroke cycle engines of considerable output.

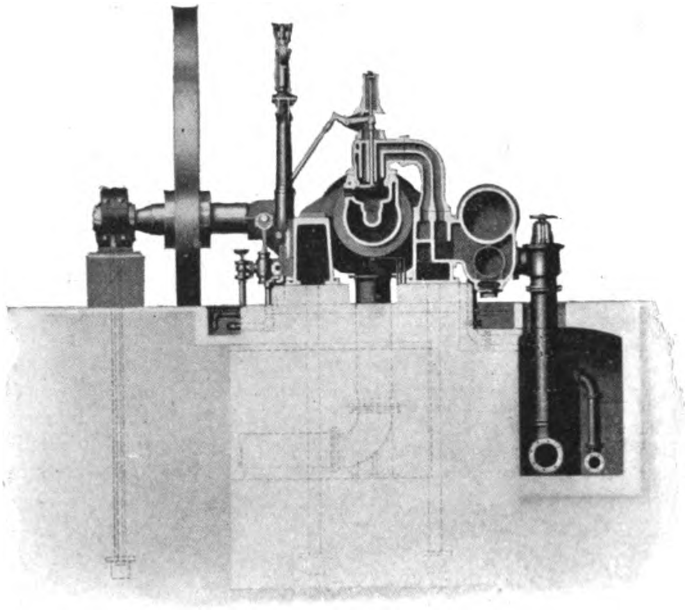

FIG. 3.—SECTION THROUGH SUCTION VALVE OF KOERTING GAS ENGINE.

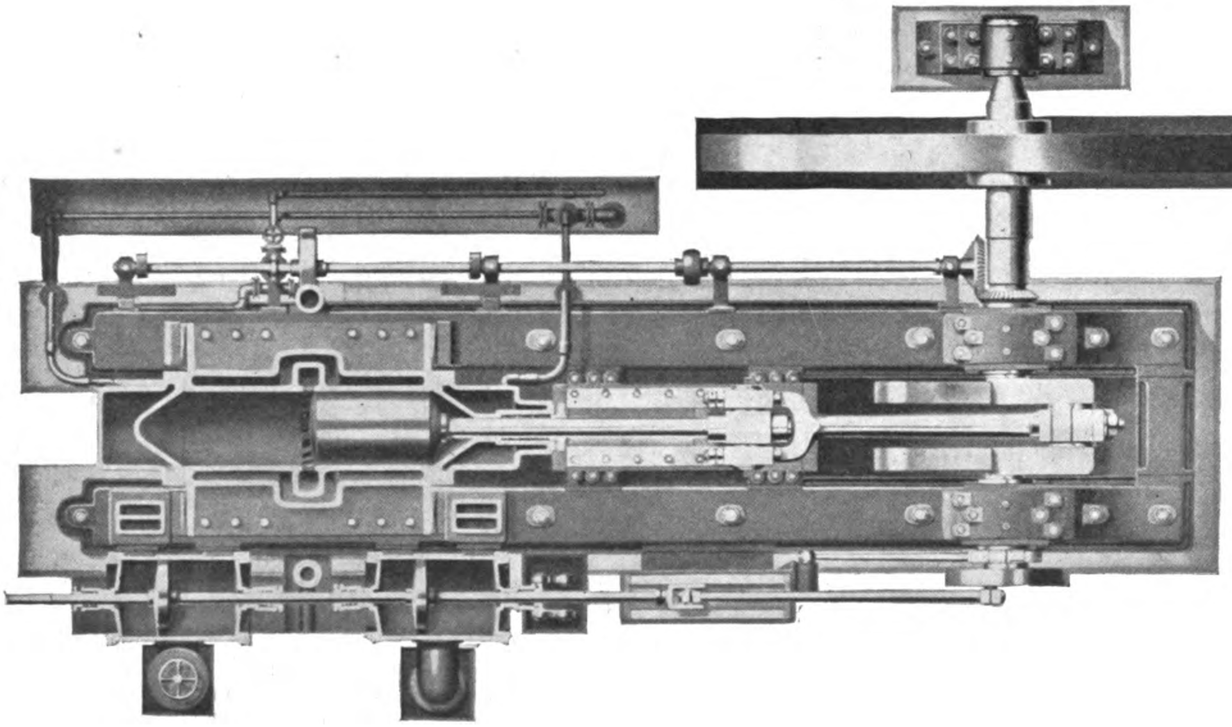

FIG. 2.—SECTIONAL PLAN VIEW OF THE KOERTING TWO-STROKE CYCLE GAS ENGINE.

So far as the writer is aware, the only American builder of two-stroke cycle engines of large size is the De La Vergne Refrigerating Machine Company, New York. This company builds the Körting design of engine, originated by the German firm of Körting Brothers, Körtingsdorf, near Hanover. Fig. 1 is a side elevation of the Körting engine; Fig. 2 is a sectional plan view, and Fig. 3 is a transverse section through the cylinder, admission valve chamber and gas pump. Individual pumps for gas and air are used, as indicated by Fig. 1, but a single rod drives both pistons. The pump rod is actuated from a crank disc on one end of the main crank shaft, and the valves of both pumps are actuated by an eccentric on the main shaft through a system of reach rods and rocker arms; this gearing is clearly shown in Fig. 1. This engine is double-acting, and has no exhaust valves; the exhaust ports are in the center of the cylinder, and are covered and uncovered by the piston, as shown by Fig. 2. The piston, therefore, is made of a length equal to the stroke minus the length of the exhaust ports.

Admission valves of the poppet type are used, as shown by Fig. 3; these are opened by cams on a secondary shaft running parallel with the cylinder and driven by equal gears from the main shaft. This secondary shaft also drives the governor. Referring to Fig. 2, it will be seen that the piston is at the crank or "inner" end of its travel, having just uncovered the exhaust ports and allowed the products of combustion to escape. Immediately upon the opening of the exhaust ports, the air pump (at the crank end of the cylinder) delivers a stream of air to the cylinder which drives out the remnant of burnt gases and forms a barrier between the exhaust ports and the charge of mixed gas and air which is admitted an instant later. The mixture of gas and air is effected in the passages leading to the admission valve (see Fig. 3.) The charge is compressed, of course, together with the scavenging air by the piston upon its return stroke, ready for firing. The compression pressure ranges from 150 to 175 pounds per square inch. The pressure to which the air and gas are compressed by the pumps before delivery to the cylinder is about 9 pounds.

The governor controls the valves of the gas pump and also controls a throttle valve in a by-pass between the delivery ports of the pumps and the compression channels leading from the pumps to the admission valve chamber. The action of the governor is to delay the delivery of gas as the load is reduced, thereby reducing the total quantity sent into the cylinder; this is a refinement of the second method of throttling mentioned at the beginning of this article. With high compression pressures employed in the Körting engine, the variation in the ratio of gas to air in the cylinder is not of so much importance, especially as there is no variation in the quality of the charge proper; the proportion of gas to air delivered to the admission valve after the first delivery of air alone to drive out the exhaust gases is not changed, but the quantity of air first sent into the cylinder is larger, and the quantity of mixed gas and air delivered afterwards smaller, as the load on the engine decreases. It is stated by the builders that the body of air used for scavenging and the body of the charge of combustible mixture remain practically distinct in the cylinder.

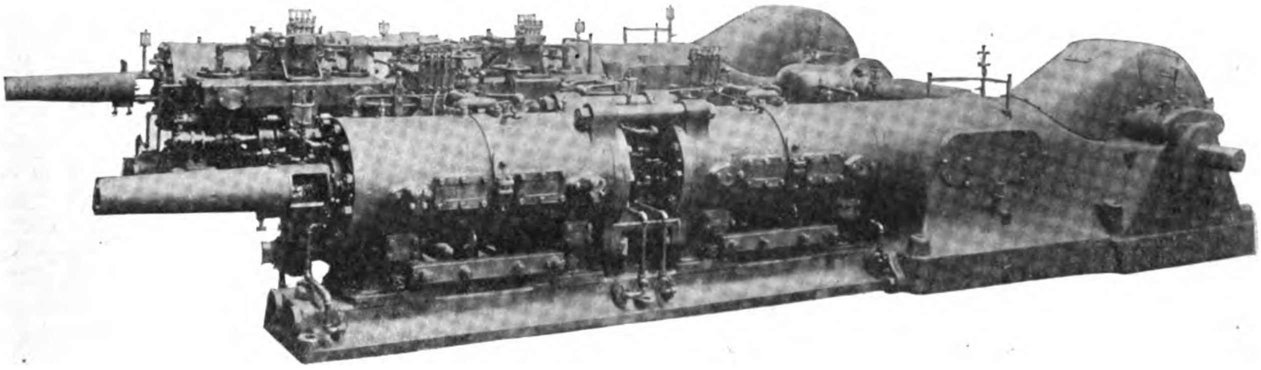

FIG. 4.—WESTINGHOUSE DOUBLE-CRANK FOUR-STROKE CYCLE GAS ENGINE.

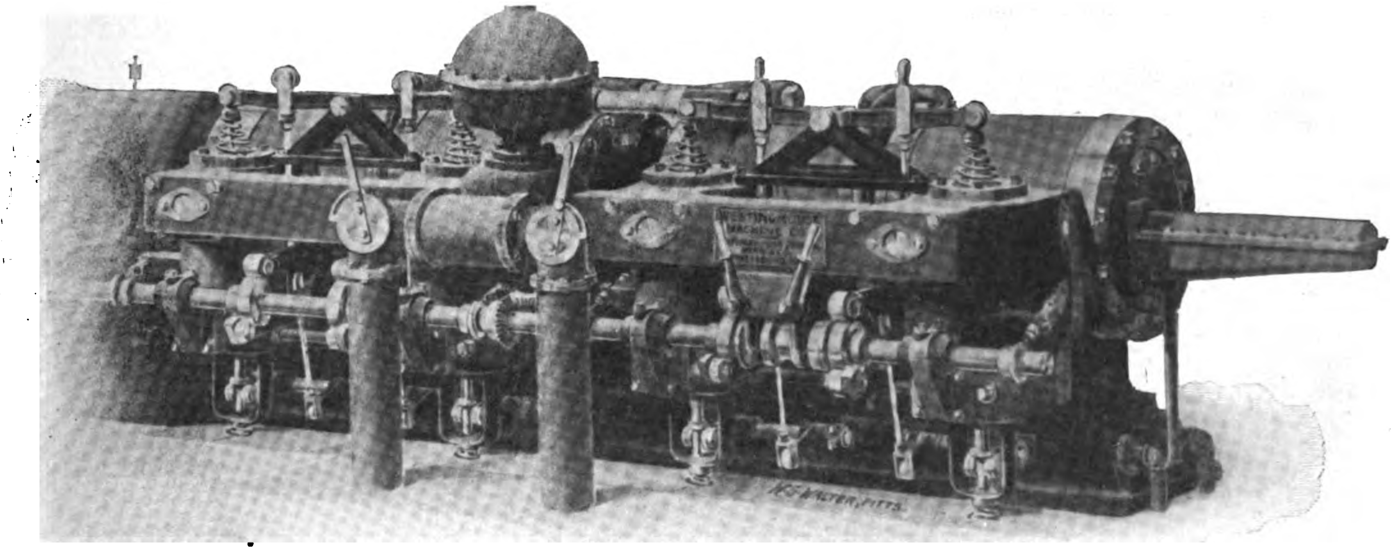

FIG. 5.—VALVE GEAR OF THE WESTINGHOUSE SINGLE-CRANK FOUR-STROKE CYCLE GAS ENGINE.

Electric ignition is employed, and the igniter mechanism is actuated through a gear which is so mounted on the shaft that its angular position with respect to a fixed point on the shaft may be adjusted; consequently the time of ignition may be adjusted to suit the quality of the gas used. Lean gases require ignition considerably in advance of the point of ignition for rich gases.

The engine is started by means of compressed air, and the air inlets for this purpose are so arranged that the compressed air does not enter at the extreme ends of the cylinder where the charges are being compressed during the process of starting, so that these charges are not weakened appreciably by the air used for starting. A double-acting piston valve driven from the secondary shaft by an eccentric controls the admission of compressed air for starting, exactly as the ordinary slide valve controls the admission to a steam engine cylinder. Two charges of compressed air usually suffice to start the engine to running regularly.

The working cylinder is, of course, water-cooled, and the piston and piston rod are also cooled, but to a greater degree than the cylinder barrel. The object in keeping the piston and rod temperatures below that of the cylinder is, of course, to avoid difficulty due to disproportionate expansions.

The largest four-stroke cycle gas engines built thus far in this country are those of the Westinghouse Machine Works. The vertical single-acting Westinghouse gas engine is very generally familiar to those interested in the subject. The general features of built-up cranks enclosed in a housing, adjustable concentric journals, cam and roller valve-gear, and compressed-air starting arrangement characteristic of the vertical design described fully in the technical papers a few years ago, have all been retained. The entire upper cam shaft has, however, been dispensed with, a single cam shaft, which is mounted within the housing, serving to actuate all of the valves. It is driven by single reduction gearing directly from the main shaft, and upon it are mounted two sets of cams, one for the exhaust valve and the other for the admission valve and the igniters. A single cam for each cylinder is employed instead of two, as formerly, to operate both the admission valve and the igniter. The exhaust mechanism is provided with an auxiliary cam of opposite throw at the side of the main exhaust cam, which is also engaged at the starting of the engine, thereby opening the valve at each stroke. Compressed air for starting is then admitted to one cylinder by a special double-throw cam mounted on the end of the cam shaft, thereby allowing this cylinder to operate for the time being as an air motor. During this operation both the admission valve and the igniter from this cylinder are thrown out of service by a clutch operated automatically by the compressed air system.

The governor is mounted at the end of the engine on a short vertical shaft, driven from the main shaft, as shown in Figs. 7 and 8. It is of the fly-ball type, the main fulcrum pins being knife edges, and the motion is transmitted through roller contacts; it is housed in an iron casing. Adjustment of the spring tension, and hence the speed of the engine during operation, is provided.

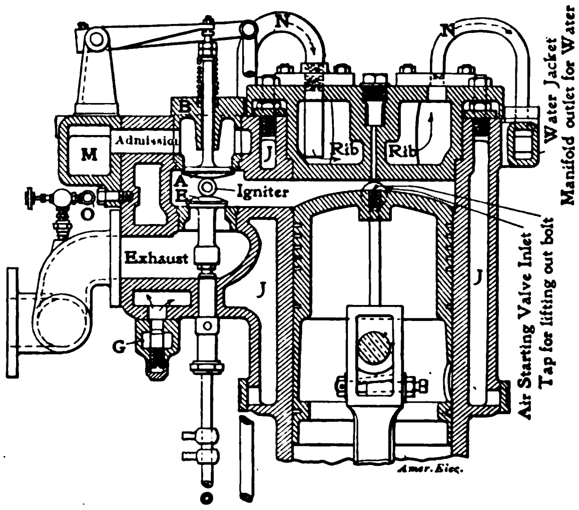

FIG. 6.—DETAILS OF WESTINGHOUSE VERTICAL GAS ENGINE.

Formerly the cylinder casting contained only the exhaust valves and chambers, while the cover or head contained both the admission valves and igniters, and was bolted to the upper face of the castings by long stud bolts. In the new design, shown in section in Fig. 6, the main cylinder casting contains all of the valves and the igniters, while the cover is simply a plain cylinder head cored out for circulating water. This permits the removal of the piston without dismantling the upper works of the engines.

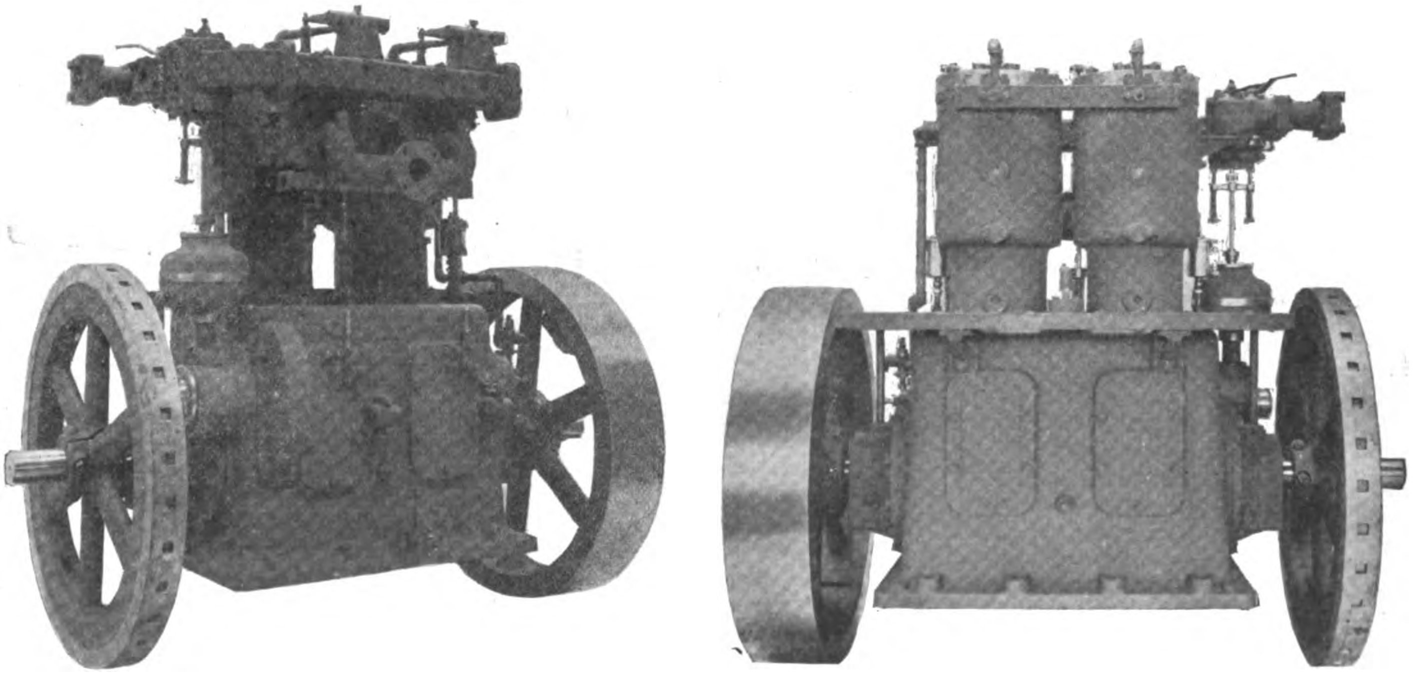

FIG. 7.—FRONT AND BACK VIEWS OF THE WESTINGHOUSE TWO-CYLINDER VERTICAL GAS ENGINE.—FIG. 8.

Gas and water manifolds (*N*, Fig. 6) separate from the cylinder casting and bolted on at opposite sides are provided to connect the different chambers, so that without increasing the complexity of the cylinder casting, the upper part of the engine has been largely cleared of working parts.

A feature of the new design is the relative location of admission and exhaust valves, *A* and *E*. These seat vertically in opposite directions, and are held on their seats by spiral springs. They are both removed through the same opening in the casting. The admission valve *A* is mounted in a cast-iron bonnet *B*, and the entire part may thus be removed without dismantling. This leaves sufficient room for taking out the exhaust valve *E*, and its seat if necessary. Formerly a special opening was provided for the removal of the exhaust valve. The arrangement of the valves has been largely instrumental in reducing the working temperature of the exhaust valve, as the cool mixture entering the cylinder flows directly across the exhaust-valve head. This has made it possible to use uncooled valves on larger sizes of engine than formerly. Water-cooled valves are, however, employed in sizes above 125 horse-power, and on smaller sizes when used with special gases. The valves are of forged steel and are bored throughout their length for the reception of a small copper water tube. This conducts cold water to the valve head where it discharges into a recess and returns through the annular space between the tube and spindle bore. In locations where the cooling water is obtained from artesian wells and contains acid impurities, cast-iron valves are used, of the construction shown in Fig. 6. Cooling water circulates first around the combustion and exhaust chambers, these being the parts subjected to the greatest heat, then around the cooler parts.

Two forms of mixing valves are used, according to the character of fuel gas. With natural or illuminating gases which are quite free from solid or viscous impurities, a two-section piston valve is employed, directly controlled by the governor to increase or decrease the port opening of each section in proportion to the load on the engine, while the mixture proportion is secured by rotating the valve on its axis in the valve casing, which has ports nominally registering with those of the valve. These two mixing valve sections are each controlled by a separate lever, so that the ratio of gas to air can always be adjusted and constantly maintained with accuracy. With producer or other lean gases a double-beat poppet valve is employed and the proportion secured by independent plug valves, each having graduated ports.

The vertical type is built in sizes ranging from 10 horse-power to 200 horse-power, the larger engines of this group having three cylinders instead of two. For outputs above 200 horse-power double-acting construction is employed, and for very large outputs, the engines are built in the horizontal form, with two tandem cylinders, as indicated in Fig. 5, which shows the valve-gear side of the cylinders of such an engine. Fig. 4 illustrates the twin tandem horizontal type built for outputs up to 4000 horse-power (1000 horse-power per cylinder).

In general construction, the double-acting engines embody the essential characteristics of the single-acting type, together with many established features of modern steam engine practice. For example, in the horizontal design, from the crank-shaft to the cylinders the construction is that of a horizontal steam engine, suitably strengthened in proportion to the increased maximum pressures involved. The design of the cylinders, pistons and valves, of course, departs materially from steam engine practice. The cylinders are double walled with the outer walls split peripherally to permit of independent expansion and contraction when subjected to heating and cooling in operation, and to relieve cooling stresses in casting. The two tandem cylinders are united at the top by heavy tie rods and at the bottom by a cast iron distance piece. Both inner cylinder heads are split diametrically and held together by bolts; the seam is a ground fit no packing being used. Straight ports at the end of each cylinder communicate with the combustion chambers, which are cast integral with the cylinder.

The relation of admission and exhaust valves is quite similar to that of the single-acting type shown in Fig. 7, and the entire cam mechanism is but an adaptation of that of the vertical to the horizontal engine. The mixture is adjusted in the same manner as in the vertical type and controlled by a governor of similar construction positively driven from the cam shaft, which receives its motion from the main shaft through helical gearing. The combustion chambers and exhaust passages are all water cooled, as are also the pistons and piston rods, all the horizontal engines being double-acting. The pistons are fitted with spring packing rings and have babbitted bearing surfaces. They are secured in position on the rods by internal keys and present plain convex surfaces to the burning gases. Circulating water is admitted to the pistons through the piston rods; it enters at the cross-heads through flexible pipe connections provided with swinging joints. It then flows through the hollow piston rod to the front and rear pistons successively, through which it circulates, eventually emerging through a bronze tail rod which extends through the rear cylinder head, and emptying into a cast-iron jacket piped to the discharge main.

The cylinder oiling is accomplished automatically by multi-plunger pumps driven from the valve mechanism. The engine is started by compressed air in the same manner as the vertical type.

The method of ignition in all types is electric, at either high or low voltage, as may be desired. In plants where lighting current is available, current is taken directly from the mains, passing through incandescent lamps, both for the purpose of limiting the current to the amount required and for indicating the continuity of the supply. The igniter is of the standard make and break type. It is removable in one piece in the form of a plug, and is operated by a vertical rod from the cam shaft. The igniter enters the side of the combustion chamber, as shown in outline in Fig. 6, where it profits by the cooling effects of the entering gases.

In the twin tandem, double-crank engine shown, the cranks are placed at 90 degrees, giving four impulses per revolution, and a crank effect corresponding to that of the cross-compound, double-acting steam engine.

Using a mixture of gas and air of unvarying quality initially proportioned according to the nature of the gas used, and increasing or decreasing the quantity by the governor according to the load, obviously necessitates variable compression, but the builders state that the difference in theoretical economy due to the lower compression at light loads is more than compensated for by maintaining the mixture of gas and air constant in the best proportion for perfect combustion.

The pressures usually obtained with natural gas are approximately 350 lbs. explosion pressure, 120 lbs. compression pressure, and 30 lbs. exhaust. This exhaust pressure at full load is comparatively low and decreases in proportion as the load falls off, so that the necessity for elaborate mufflers is obviated.

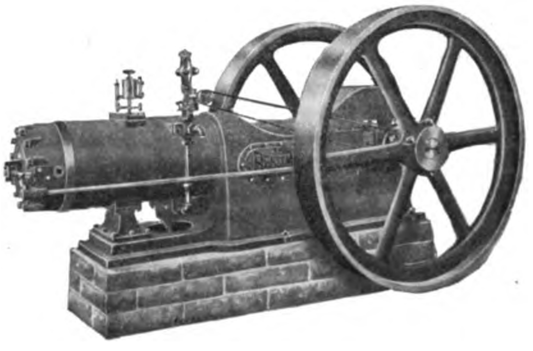

FIG. 9.—BESSEMER GAS ENGINE.

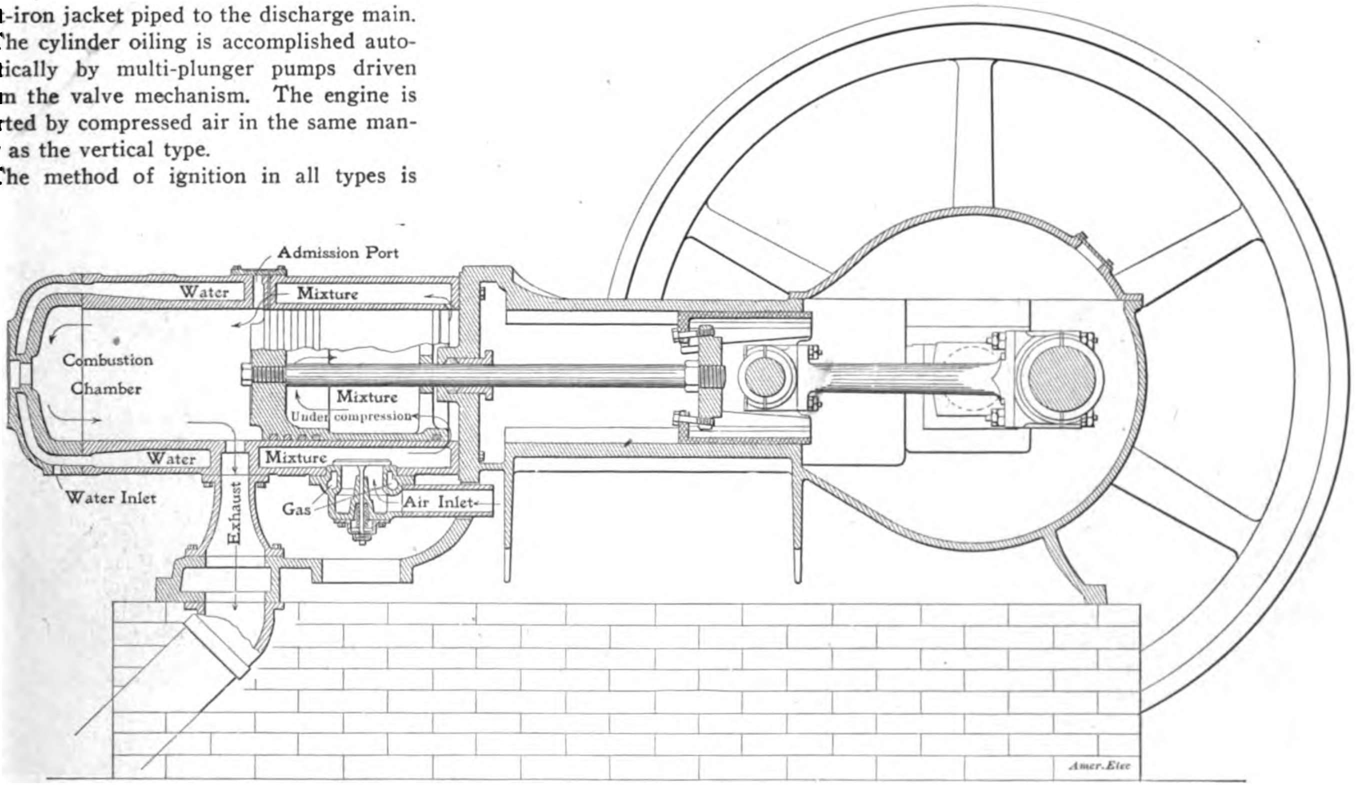

FIG. 10.—SECTIONAL ELEVATION OF BESSEMER GAS ENGINE.

The Bessemer gas engine, illustrated by Figs. 9 and 10 is a compact two-stroke cycle machine of the type referred to in an earlier paragraph. The front part of the cylinder is a pump and receiver for the combustible mixture; the admission port is in the top side of the cylinder and the exhaust port is in the bottom side, both being covered and uncovered by the piston. Starting from the position of parts shown in Fig. 10, the cycle is as follows:

A charge having just been admitted to the working cylinder from the receiver in front of the piston, as indicated by the arrow in the admission port, the piston is carried back towards the cylinder head, closing the admission and exhaust ports and compressing the charge behind it; at the same time it draws gas and air into the receiver end of the cylinder structure through the single poppet valve beneath the cylinder, the valve being lifted by atmospheric pressure. When the piston reaches the end of its stroke the compressed charge behind it is fired, and as it is driven forward it compresses the receiver charge in front of it. It uncovers the exhaust port before it reaches the admission port, and when the latter is passed, the slightly compressed mixture in the receiver rushes into the cylinder and is deflected toward the rear by the curved recess in the piston head so as to prevent it from passing straight across to the exhaust outlet.

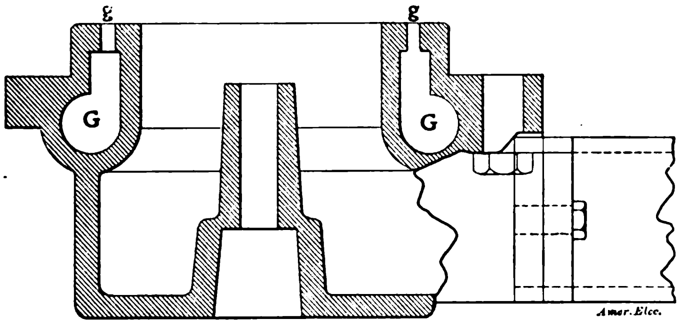

FIG. 11.—DETAIL OF BESSEMER INTAKE VALVE.

The one valve on the engine controls the delivery of both gas and air to the mixing and receiver chamber; gas is delivered to an annular chamber, *G*, Fig. 11, in the valve casing, whence it escapes through small holes *g*, when the valve is raised by atmospheric pressure through the air inlet. Governing is accomplished by throttling the supply of gas and thereby varying the quality of the mixture. Ignition is electric, the igniter mechanism being actuated by a small secondary shaft shown lying parallel with the cylinder and bed in Fig. 9. These engines are built by the Bessemer Gas Engine Company, Grove City, Pa. The single-cylinder engines are built up to 75 horse-power, and double-cylinder engines up to double that output, of course.

A compact two-stroke-cycle engine is also built by the Capital Gas Engine Company, Indianapolis, Ind., but only in small sizes. Fig. 12 is a sectional elevation of this machine, in which *A* is the inlet valve for the receiver; *T* is a throttle valve controlling the quantity of mixture passed through the admission port when it is uncovered by the piston; *D* is a deflector plate on the piston head for directing the incoming charge to the upper part of the cylinder, and *E* is the exhaust port. The operation of the engine is similar to that of the Bessemer engine just described. The exceptions are that the crank chamber serves as the receiver, no cross-head is used (the engine being built for small outputs), and the igniter is actuated by a pin, *p*, set in the piston head, so that no secondary shaft is required. A relief cock is screwed into the opening *R*. The throttle, *T*, is controlled by a flyball governor mounted on the main shaft. *G* represents a sight-feed for gasoline when that is used as fuel. This little engine is known as the "Hoosier."

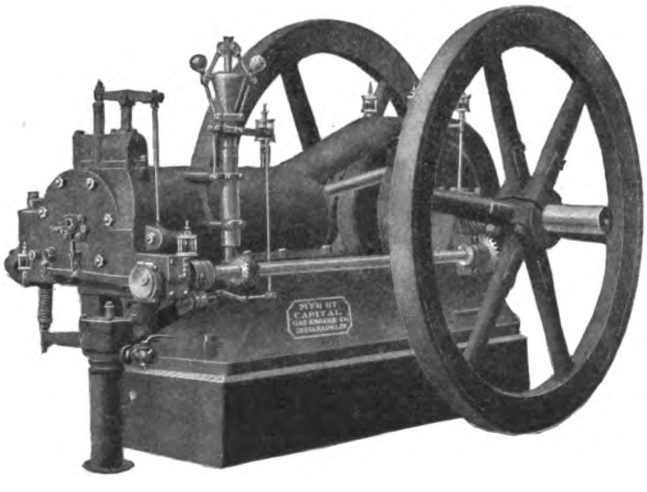

FIG. 13.—CAPITAL GAS ENGINE.

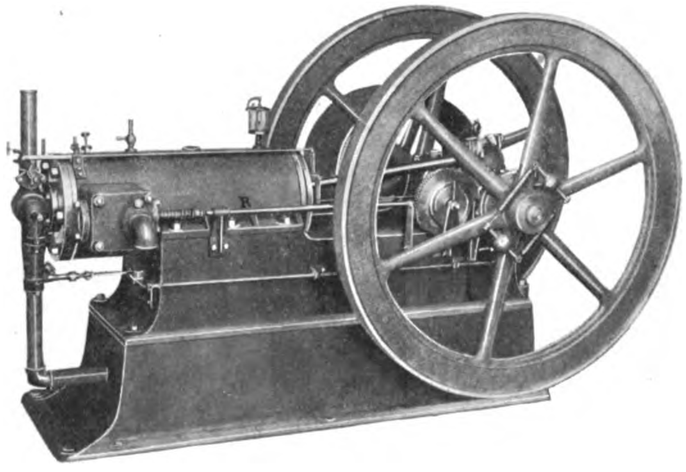

FIG. 15.—CHARTER GAS ENGINE.

The chief product of the Capital Company, however, is a four-stroke-cycle engine of the horizontal type, which is built in sizes up to 150 horse-power per cylinder; the modifications in the larger sizes are in frame and base construction chiefly. As Fig. 13 shows, the secondary shaft, characteristic of all four-stroke engines, is driven through helical gears from the main shaft and drives the governor through similar gears. Regulation is by throttling of the complete mixture; a butterfly valve in the delivery passage is operated by the governor to this end. Fig. 14 shows the arrangement of this valve and the other valves of the engine. The gas and air are mixed in the chamber marked "Mixer," and the butterfly valve *B* controls the passage of the mixture to the admission valve *A*, which is opened by a cam on the secondary shaft *S* and seated by a spring, as usual. The exhaust valve, *E*, is similarly opened and closed. The igniter plug is set into the center of the cylinder head, where it is swept by the entering charge; the igniter is operated by an eccentric on the end of the secondary shaft, as shown in Fig. 13. Capital engines are also built with "hit-and-miss" regulation.

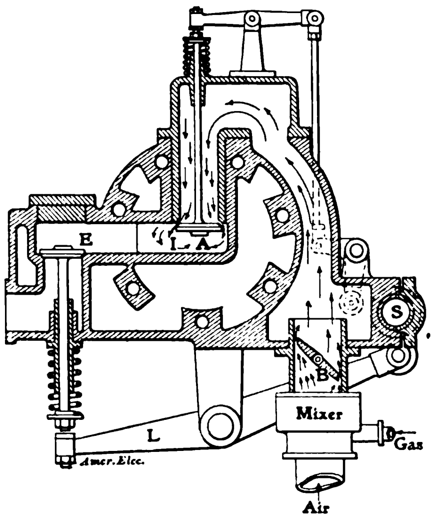

FIG. 14.—VALVES OF CAPITAL GAS ENGINE.

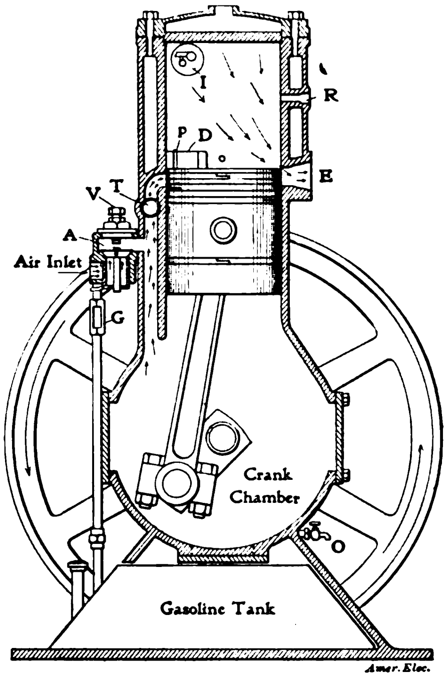

FIG. 12.—HOOSIER GAS ENGINE.

The Charter engine, Fig. 15, is of the hit-and-miss four-stroke-cycle class. It embodies the somewhat unusual features of a shaft governor and a very short secondary shaft lying parallel with the crank shaft. The missing of a charge when the speed is excessive is accomplished by cutting off the supply of gas and allowing the cylinder to be filled with air only, during the suction or charging stroke. The gas valve is actuated by the small rod shown parallel with the base of the engine in Fig. 15, and indicated by *r* in Fig. 16. The end of this rod near the shaft carries a thin blade of steel, the end of which is normally in alignment with the end of a rocking lever which is moved to and fro by a cam on the secondary shaft. The lever strikes the end of the blade and pushes the gas valve open regularly so long as the speed is normal; an increase of speed causes the governor to swing the end of the valve rod to one side just enough to cause the lever to miss the end of the thin blade carried by the valve rod, thereby allowing the gas valve to remain closed.

The rod *R*, Figs. 15 and 16, opens the exhaust valve and is actuated by a cam on the short secondary shaft, of course. The admission or intake valve *I*, Fig. 16, is opened by atmospheric pressure from without when the piston goes forward and creates a partial vacuum behind it after the exhaust stroke of the preceding cycle has been completed. Ignition is usually electric, although the Bunsen tube is furnished when desired. Firing is accomplished by means of an individual rod lying along the top of the cylinder (see Fig. 15) and reciprocated by a cam on the secondary shaft. The Charter engines are built by the Charter Gas Engine Company, Sterling, Ill.; they are fitted to use gasoline as fuel when desired.

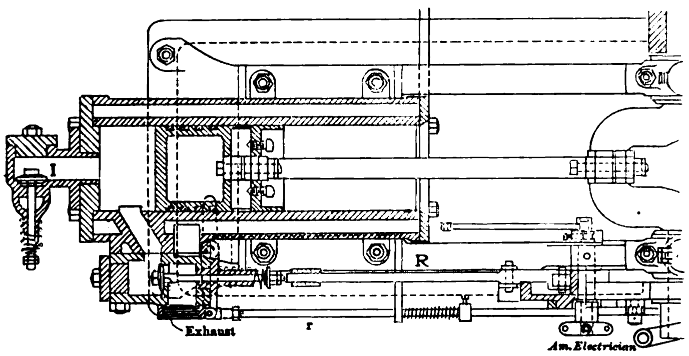

FIG. 16.—DETAILS OF CHARTER ENGINE.

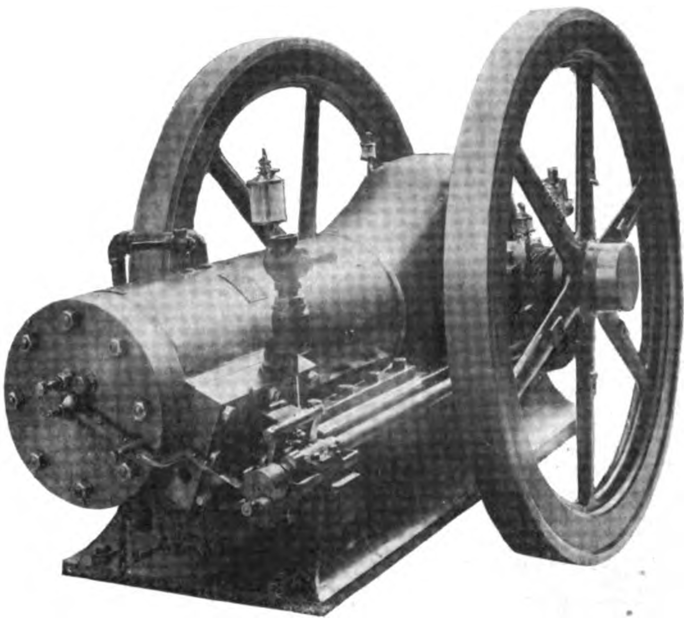

FIG. 17.—FAIRBANKS GAS ENGINE.

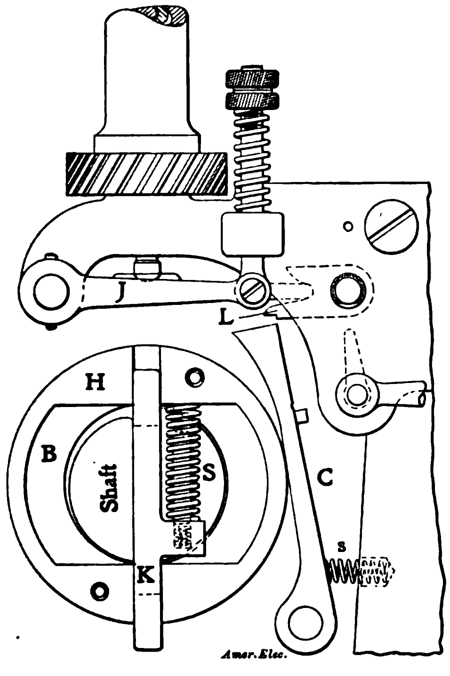

FIG. 19.—DETAILS OF FAIRBANKS GOVERNOR.

An engine of the "hit-and-miss" class which embodies several notable features of recent design is the Fairbanks machine, shown in perspective by Fig. 17. Both the admission and the exhaust valves are positively opened by cams on the secondary shaft and seated by helical springs; they are of the poppet type, as usual. Both valves are mounted in a single chest bolted to the side of the cylinder, and the chest, valves and tappets are all removable, together with the mixing chamber and gas valve, as indicated by Fig. 18, which shows this group of parts. The tappets are interposed between the valve stems and the cams on the secondary shaft for the purpose of obviating the side thrust on the valve stems which is unavoidable when the cams impinge against the valve-stem heads. The left-hand tappet in Fig. 18 opens the admission valve and also the gas valve, located in the mixing chamber bolted to the upper edge of the main valve chest.

The engine is water-cooled, of course, and in order to insure cool, smooth-working valves, the jacket water passes first into the jacket of the valve chest, then around the valves, and thence to the main cylinder jacket.

The engine works on the four-stroke cycle, and the method of omitting an explosion when the speed is excessive is remarkably simple and applied by mechanism just as simple and notably compact. Reference to Figs. 19 and 20 will facilitate the explanation of this apparatus. The head, *H*, mounted on the end of the secondary shaft is driven continuously by helical gears from the crank shaft, and as long as the sliding key *K* remains in the position shown in Fig. 19 the secondary shaft revolves with the head, being driven by the key; the spring *S* tends to hold the key in the operative position shown. A lever cam, *C*, is normally pressed lightly against the periphery of the head *H* by the spring *s*; this latter spring is much weaker than the spring *S*, so that when the projecting end of the key *K* comes around to the point of contact between the head *H* and the cam *C*, it knocks the latter away and continues to hold the secondary shaft locked to the revolving head *H*. When the speed exceeds the normal rate for which the governor is adjusted, the outward movement of the governor balls depresses the central spindle and thereby forces the end of the lever *J* downward; the latch *L* is thereby lowered until it catches the upper end of the lever cam *C*; when the end of the key *K* next comes around to the cam lever it is pressed inward by the face of the cam and the secondary shaft is thereby released and consequently it stops revolving. The key is mounted in a block, *B*, on the end of the secondary shaft, so that it stops with the shaft and keeps the latter unlocked from the revolving head as long as the cam *C* is held against it by the latch *L*. When the secondary shaft is in this arrested position, the exhaust valve is wide open and the gas and admission valves are closed, of course, so that the piston simply draws in air through the exhaust port and drives it out again until the speed falls enough for the governor to release the latch *L*. The rate of speed is adjusted by adjusting the tension of the spring which tends to draw the end of the arm *J* upward. The mechanism works with remarkable smoothness, sensitiveness and certainty.

The engine shown by Fig. 20 is not of the simple "hit-and-miss" type; it is regulated by a combination of the "hit-and-miss" and the throttling methods. The governor lever, indicated in Fig. 19 by *J*, latches the lever cam *C* directly, and is extended to a bell-crank and reach rod mechanism

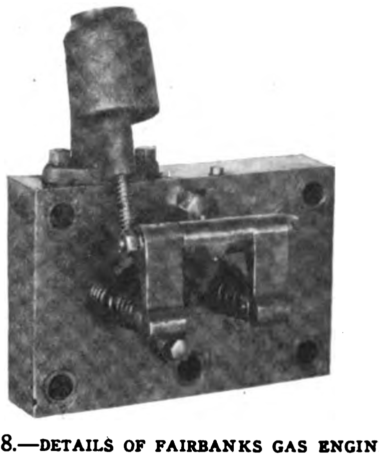

FIG. 18.—DETAILS OF FAIRBANKS GAS ENGINE.

through the medium of which it controls the quantity of fuel admitted to the cylinder, within a certain range. Beyond that range, the "hit-and-miss" mechanism comes into play. This obviously gives a refinement of control which eliminates most of the spasmodic character of the "hit-and-miss" method alone.

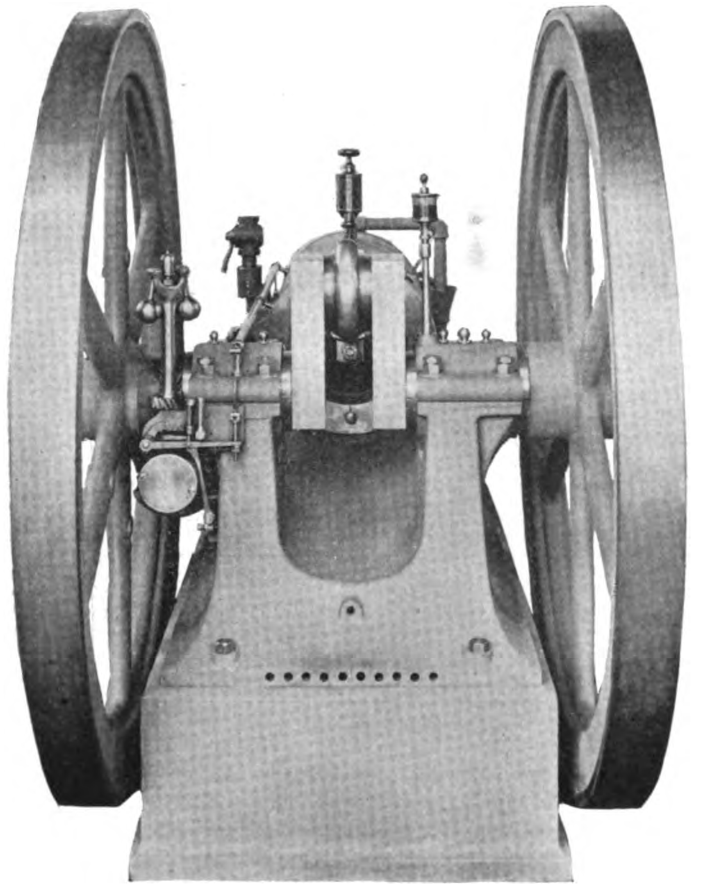

FIG. 20.—END VIEW OF FAIRBANKS GAS ENGINE.

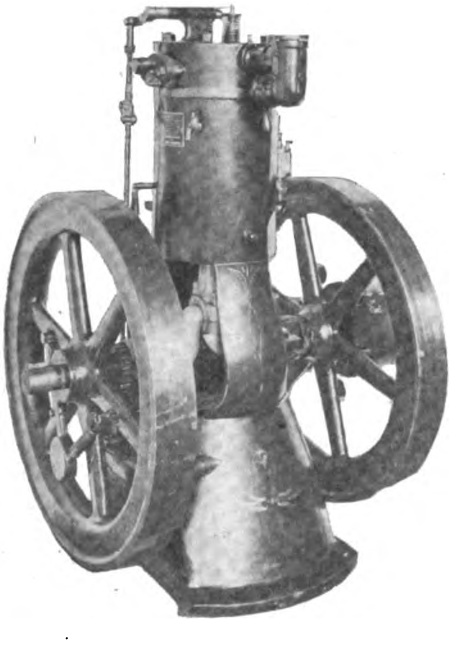

FIG. 21.—FAIRBANKS VERTICAL GAS ENGINE.

Fig. 21 illustrates the vertical engine built by the same company (The Fairbanks Company, New York). The valves are mounted directly in the cylinder head, and the method of regulation is practically the same as that described in connection with the "hit-and-miss" horizontal engine, though the mechanism is different. A shaft governor is employed, and the secondary shaft is a very short one, parallel with the main shaft, as in the case of the Charter engine. A cam on the secondary shaft pulls the valve rod downward through the medium of a rocker-arm and a helical spring, the upper end of which shows just above the near flywheel rim, pulls it upward. When the rod is in the lowest position the exhaust valve is open, and when the speed exceeds the normal, a cam controlled by the governor catches the valve rod rocker-arm and holds it down until the cam on the secondary shaft comes around again. The rocker-arm on top of the cylinder serves to actuate both the admision and the exhaust valves.

The ignition is electric on all of these engines. The vertical engines are equipped with the usual form of make and break igniter, and the igniter arm is caught by a latch on the valve rod. The igniter mechanism used on the horizontal engines, however, is new and highly ingenious. It is the Goodson magneto igniter and spark plug, and is described fully under the head of Igniters farther on in this article.

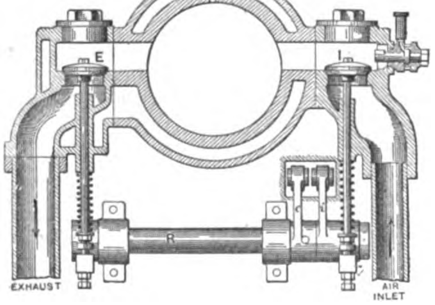

FIG. 24.—VALVES AND VALVE MECHANISM OF FOOS ENGINE.

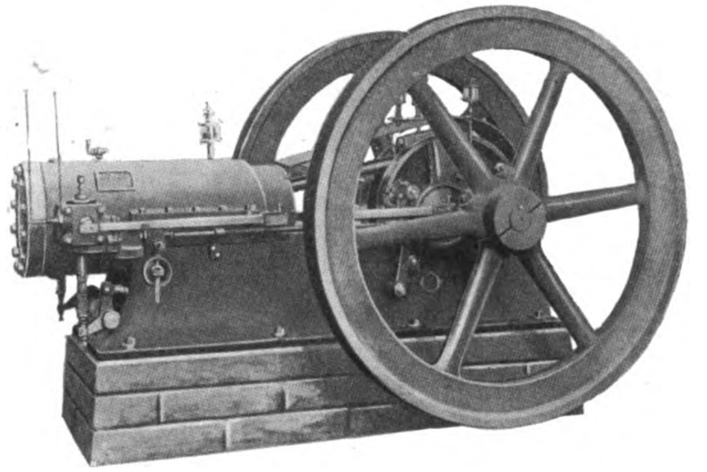

FIG. 22.—FOOS GAS ENGINE.

Another "hit-and-miss" engine having positively opened gas and admission valves is that manufactured by the Foos Gas Engine Company, Springfield, Ohio, and illustrated by Fig. 22. Like the Charter and Fairbanks engines, this one has a short secondary shaft driven by plain spur gears; it operates on the four-stroke cycle. Fig. 23 shows the secondary or cam shaft, and also shows the means for adjusting the time of ignition. The igniter driving rod is driven by a crank-pin set in a disc or plate which is bolted to the gear wheel of the cam shaft, and the bolt holes are arc-shaped slots, so that the igniter crank-disc may be set ahead or backward with relation to the cam shaft, and the ignition thereby made early, normal or late, according to the requirements of the fuel gas used.

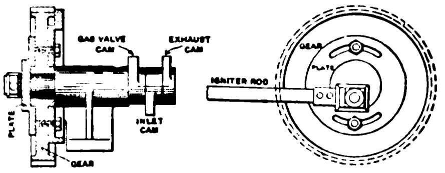

FIG. 23.—SECONDARY SHAFT OF FOOS ENGINE.

The admission and exhaust valves are opened and closed regularly by means of cams, reach rods and rocker-arms, regardless of speed or load, but the governor acts to cut off the supply of gas when the speed exceeds the normal. Fig. 24 shows the ad-

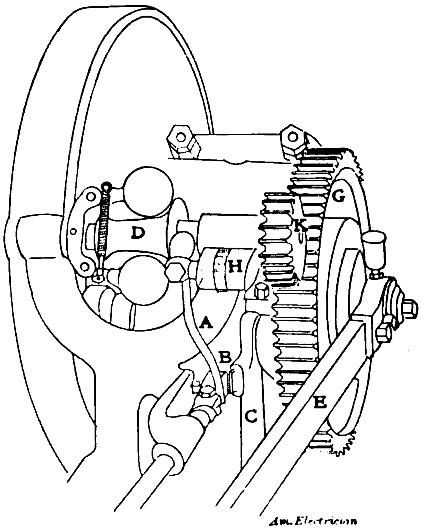

FIG. 25.—DETAILS OF FOOS GOVERNOR.

mission and exhaust valves and the valve mechanism at that end of the engine; the admission valve *I* is opened by the rocker-arm *i*, which is oscillated by a reach rod extending through the engine base to the cam shaft near the main shaft; a cam on the cam shaft (inlet cam, Fig. 23) pushes the reach rod back, and the spring on the valve stem returns it. The exhaust valve mechanism is exactly the same. The gas cam oscillates a rocker-arm, *C* in Fig. 25, the upper end of which carries a "pick" blade which normally engages a block, *B*, pivoted on the end of the gas-valve rod. When the speed exceeds the proper rate, the governor balls slide the spool *D* to the right, and the base of the spool presses against a roller on the upper end of the arm *A*, which is pivoted to the bracket *H;* the lower end of the arm *A* is thrown inward and justifies the pivoted block *B* out of the path of the pick blade on the rocker-arm *C*, so that the gas valve remains closed and the engine takes in air only. This air, however, is taken in through the admission valve and not through the exhaust valve, so that it is pure and therefore highly effective as a scavenging and cooling charge.

The ignition is electric, but the igniter contacts are different from the usual butt contracts; the stationary electrode is a spring and the moving electrode is oscillated by the igniter rod so as to make a wiping contact on the spring electrode and thus maintain clean contact surfaces. The larger sizes of engine are provided with compressed-air starting apparatus.

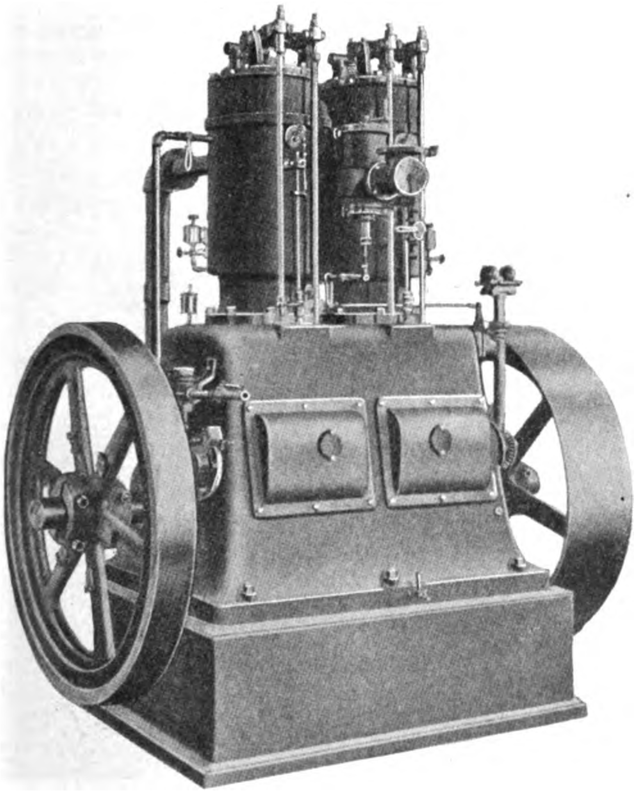

FIG. 26.—TWO-CYLINDER WALRATH GAS ENGINE.

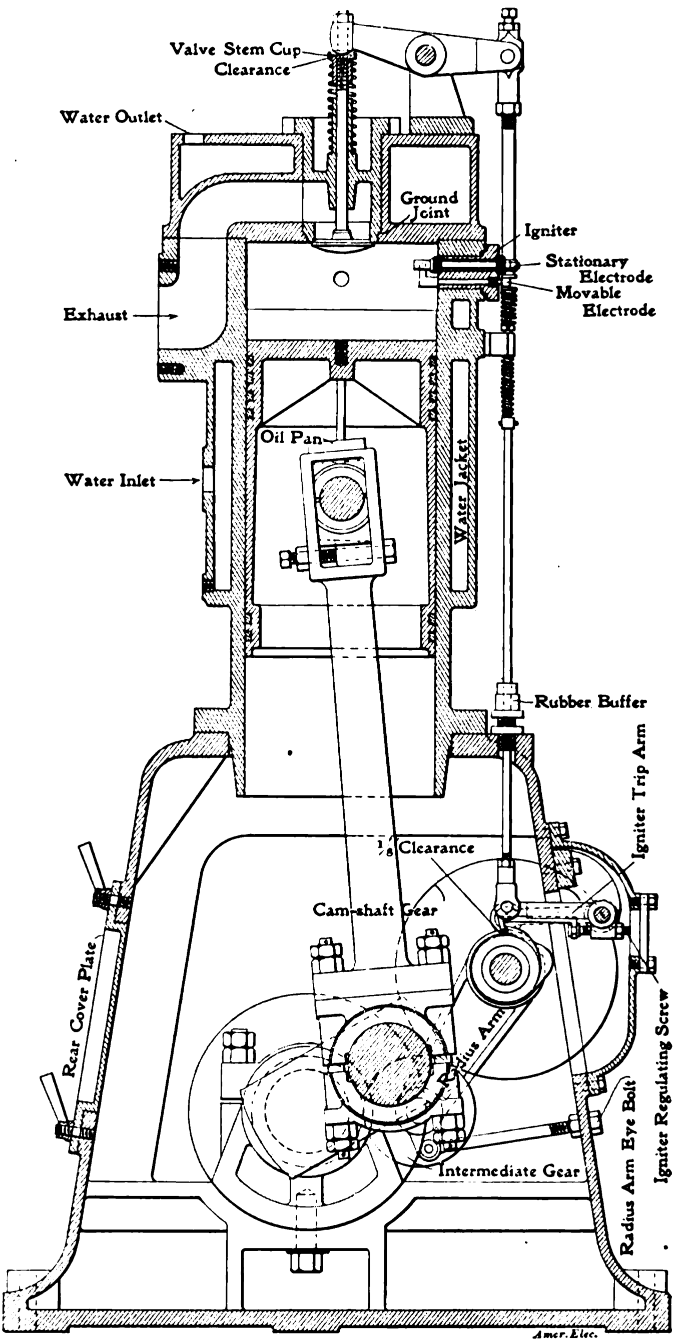

FIG. 27.—SECTIONAL ELEVATION OF WALRATH GAS ENGINE.

The Marinette Iron Works Manufacturing Company, Marinette, Wis., builds only vertical engines, operated on the four-stroke cycle. These are known as "Walrath" engines, and are built with one, two and three cylinders, according to the output. Fig. 26 shows a two-cylinder 60-h.p. engine, and Fig. 27 is a sectional elevation of one cylinder and its mechanism. The admission and exhaust valves are positively opened by means of vertical reach rods and cams on the secondary shaft; the latter is located within the crank housing, as shown by Fig. 27, and is driven through an intermediate gear journaled in the end of a swinging arm which the makers term a "radius" arm. By adjusting the nuts on the end of the "radius" arm eyebolt (Fig. 27) the meshing of the gears may be made as snug as desired, or the cam shaft may be disengaged from the main shaft entirely and its static position adjusted with relation to that of the main shaft.

The igniter is of the electric type and is actuated by an individual rod which is raised and lowered through the medium of a rocker-arm designated the "igniter trip arm." This is adjustable, as indicated in Fig. 27, so that the time of ignition may be regulated.

The governor controls a throttle valve between the mixing chamber and the admission valve-chamber which regulates the quantity of explosive mixture admitted to the cylinder. The mixing chamber and governor linkage are clearly shown in Fig. 26. The proportion of gas to air is adjustable, of course; a single valve in the mixing chamber determines the quality of mixture. As the illustration indicates, only one mixing chamber and valve are used on the two-cylinder engine; two are used on the three-cylinder engines.

The horizontal engine of the New Era Iron Works Company, Dayton, Ohio, is of the "hit-and-miss" class. A general view of the engine is given by Fig. 28, from which it will be noticed that the valve-gear is particularly compact. The familiar cam shaft parallel with the bed is employed, and this actuates the exhaust valve admission valve and igniter. The governor controls the gas valve so as to keep it closed when the speed exceeds the normal. The igniter is operated by means of a spring arm in the path of a cam on the secondary shaft, shown as in Fig. 29. Fig. 30 is a sectional view of the admission valve chamber and mixing chamber; the right-hand valve controls the admission of gas into the mixing chamber at the bottom and the left-hand valve admits the mixture to the cylinder when it is opened by the cam on the cam shaft. The gas valve here shown is the one controlled by the governor.

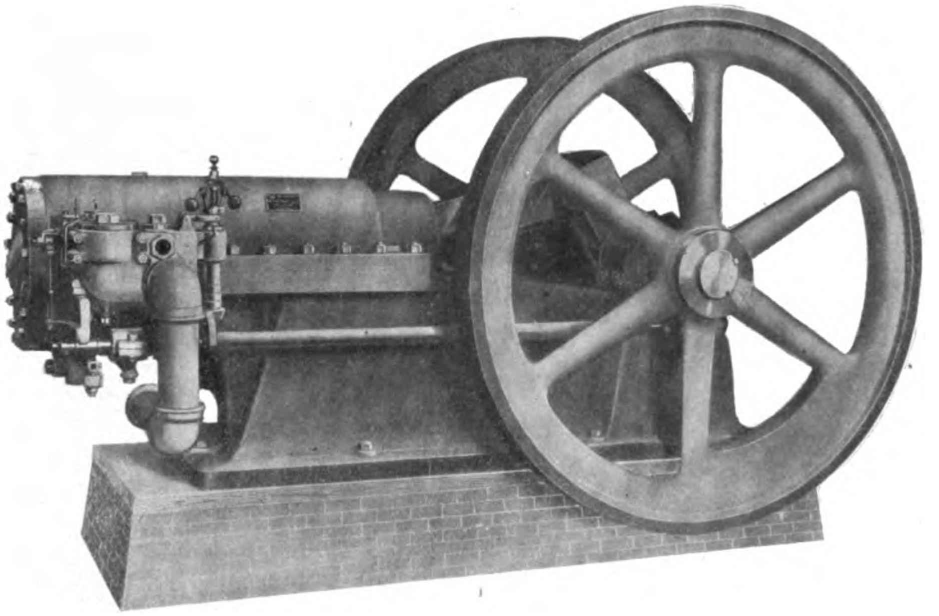

FIG. 28.—NEW ERA GAS ENGINE.

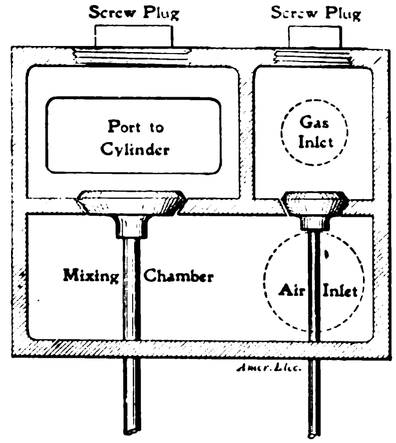

FIG. 30.—VALVE CHAMBERS OF NEW ERA ENGINE.

This engine has the unusual feature of two exhaust ports, one of which is uncovered by the piston just before the cam shaft opens the exhaust valve at the head of the cylinder. This relieves the pressure in the cylinder so that the exhaust valve mechanism has much less work to do than if the valve had to be opened against the full terminal pressure in the cylinder. The main exhaust port is connected to the exhaust-valve chamber by means of an external piece of pipe, as shown in Fig. 31, where *B* is the exhaust-valve rocker-arm; *C*, the exhaust-valve chamber; *D*, the connecting pipe, and *E*, the outlet of the main exhaust port.

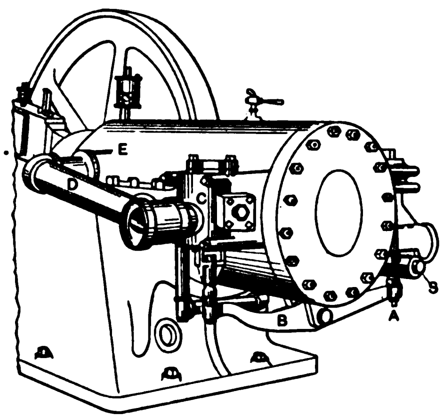

FIG. 31.—EXHAUST SIDE OF NEW ERA ENGINE.

The New Era Company has added to its line a comparatively new line of vertical throttling engines, the 50-h.p. size of which is illustrated by Fig. 32. Fig. 33 is a sectional elevation showing the arrangement of the cylinders and valves. Both the admission valves, *A*, *A*, and the exhaust valves, *E*. *E*, are opened by cams and rocker-arms and closed by springs. The cam shaft is mounted in bearings bolted to the sides of the cylinder heads and is driven by a vertical shaft through bevel gears; this latter shaft is shown to the left in Fig. 32. The governor is mounted opposite the space between the cylinders, and is driven from the cam shaft, as shown. It is located here in order to control the valve in the mixing chamber more directly than it could if mounted near or on the vertical lay shaft. The mixing chamber is on the opposite side of the engine, and a lever extends from the governor straight to the throttle valve stem, being pivoted on a support between the cylinders; this pivot is shown at *F* in Fig. 33.

The vertical engines are provided with an auxiliary exhaust port connected to the main exhaust outlet, exactly as in the horizontal engines. The connecting pipes are shown in Figs. 32 and 33.

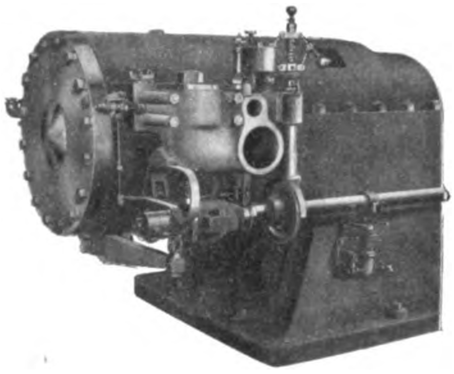

FIG. 29.—DETAIL VIEW OF NEW ERA GEAR.

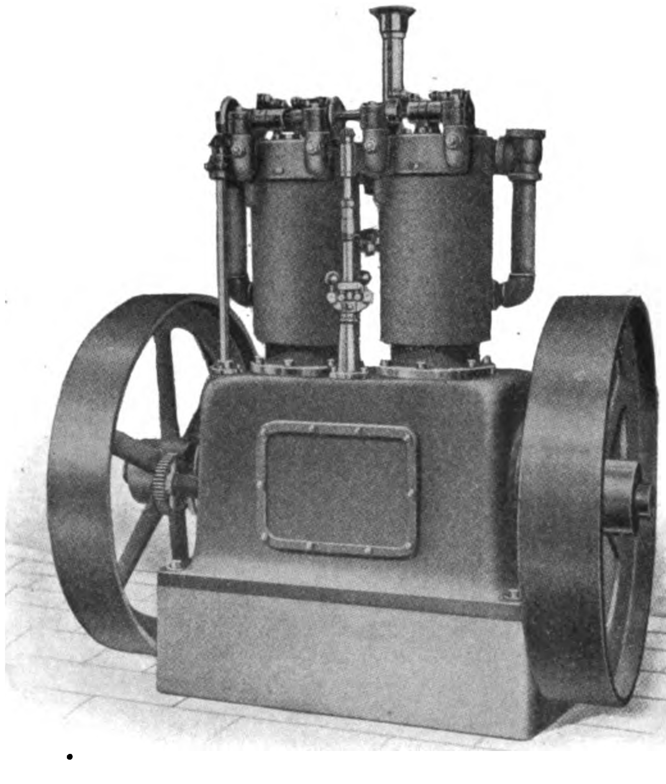

FIG. 32.—NEW ERA TWO- CYLINDER VERTICAL ENGINE.

The engine illustrated by Fig. 34 is that of the Olds Gasoline Engine Works, Lansing, Mich. Notwithstanding the name of the company, the engine here described is built to operate with gas as fuel; the same engine is adapted to use gasoline by merely adding a gasoline pump and connecting pipes and omitting the gas valve and its connection. The Olds engine is of the "hit-and-miss" type, and regulates by holding the exhaust valve open when an explosion is to be missed. The valve mechanism is unique. No secondary or cam shaft is used, although the engine works on the four-stroke cycle. A slide is reciprocated directly from the main shaft, and it carries a star-shaped cam wheel, *C*, Fig. 35, which is rotated by a pawl, *P*, pivoted on a stationary part of the engine. This action causes a tooth of the cam wheel to be brought opposite the nose, *n*, of the exhaust valve stem during one backward stroke of the slide, and a space between two teeth to be brought opposite the nose during the next backward stroke of the slide, the wheel being shifted by the pawl during each forward stroke of the slide. Consequently, the exhaust valve is opened once in every four strokes, or two revolutions, of the engine, so long as the speed remains normal or less than normal. Should the speed rise beyond normal, the governor throws the spring finger *f* inward, pushing the latch button *b* into the path of a collar, *c*, on the end of the exhaust valve stem and preventing the valve from closing after the star wheel has opened it. The relation of the button *b* to the collar *c* is more clearly shown by Fig. 36, which shows the relative positions of the valve-stem nose, the button *b*, and a tooth *C* of the cam wheel when the valve is closed; Fig. 37 shows the positions of these parts when the valve is open. Fig. 38 is a plan view of the mechanism.

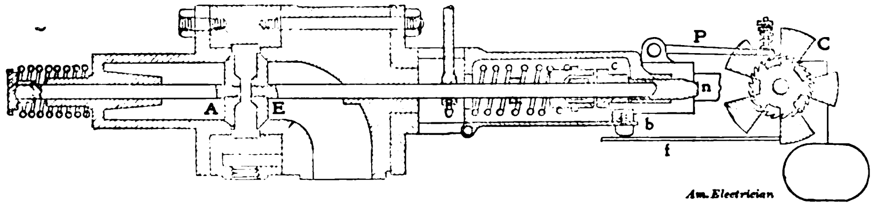

FIG. 35.—DETAILS OF OLDS GOVERNOR MECHANISM.

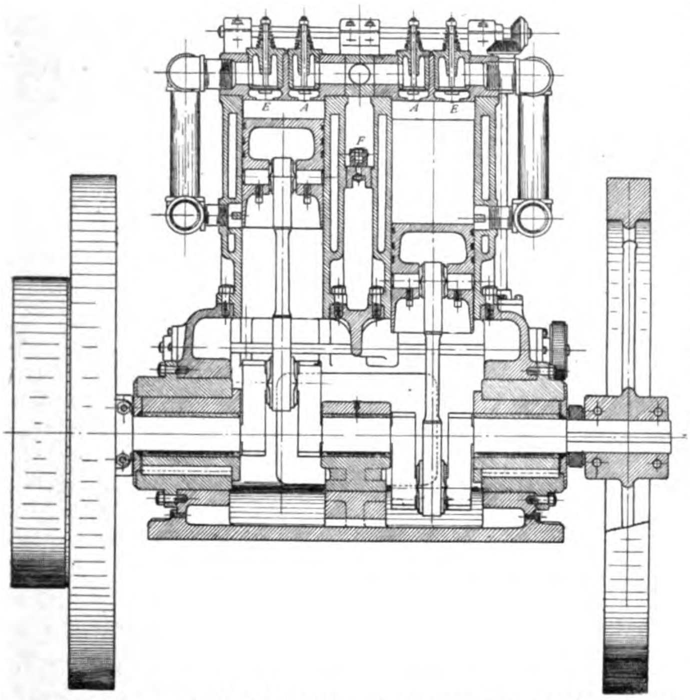

FIG. 33.—SECTIONAL ELEVATION OF NEW ERA VERTICAL ENGINE.

The Otto engine, illustrated by Fig. 39, is one of the oldest gas engines built. It is manufactured in this country by The Otto Gas Engine Works, Philadelphia, Pa., in sizes up to 140 horse-power in a single cylinder, and is of the "hit-and-miss" type. The admission valve, *A*, Fig. 40, is opened by atmospheric pressure and a gas valve which delivers gas to the passage *G* is opened by a cam on the secondary shaft so long as the speed is not above normal. The exhaust valve, *E*, Fig. 40, is opened by the usual rocker-arm and cam, and the igniter, *I*, is actuated by a pin cam and spring finger, as indicated in Fig. 39.

The admission-valve chest is indicated by *B* in Fig. 41, and the gas-valve chest by *H*. The gas valve is opened by the vertical rocker-arm *K*, Figs. 40 and 41, which is on one end of a rock-shaft; on the other end of that shaft is a horizontal rocker-arm carrying at its outer extremity a roller, *r*, which is adapted to slide along its spindle *s* under the control of the governor. When the speed is not above normal, the roller *r* is in the path of the cam *c* on the secondary shaft, and this cam opens the gas valve by raising the roller *r* and with it the end of the rocker-arm on which it is pivoted. Excess of speed causes the governor to slide the roller *r* out of alignment with the cam *c*, allowing the gas valve to be held shut by its spring; the roller *r* is shown in this position in Fig. 41. In the larger sizes, the admission valve is positively opened by means of a cam and rocker-arm, like the exhaust valve. These engines are adapted to use gasoline by making a slight change in the admission valve and providing a pump to deliver the gasoline. Fig. 42 shows the very compact and substantially built gas engine manufactured by the Pierce-Crouch Engine Company, New Brighton, Pa., and known as the Brighton engine. Fig. 43 is a semi-sectional elevation, and Fig. 44 a plan view of the engine.

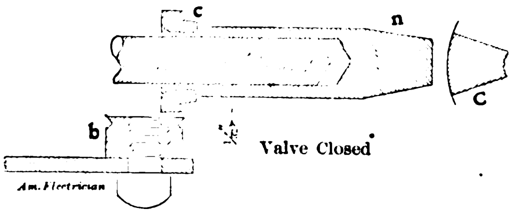

FIG. 36.—DETAILS OF OLDS GEAR.

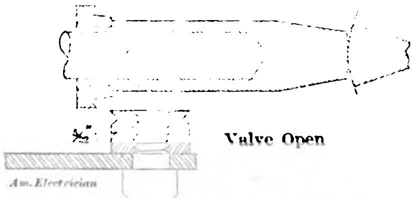

FIG. 37.—DETAILS OF OLDS GEAR.

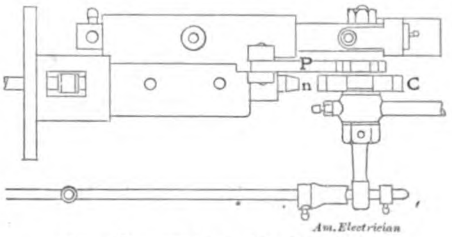

FIG. 38.—DETAILS OF OLDS GEAR.

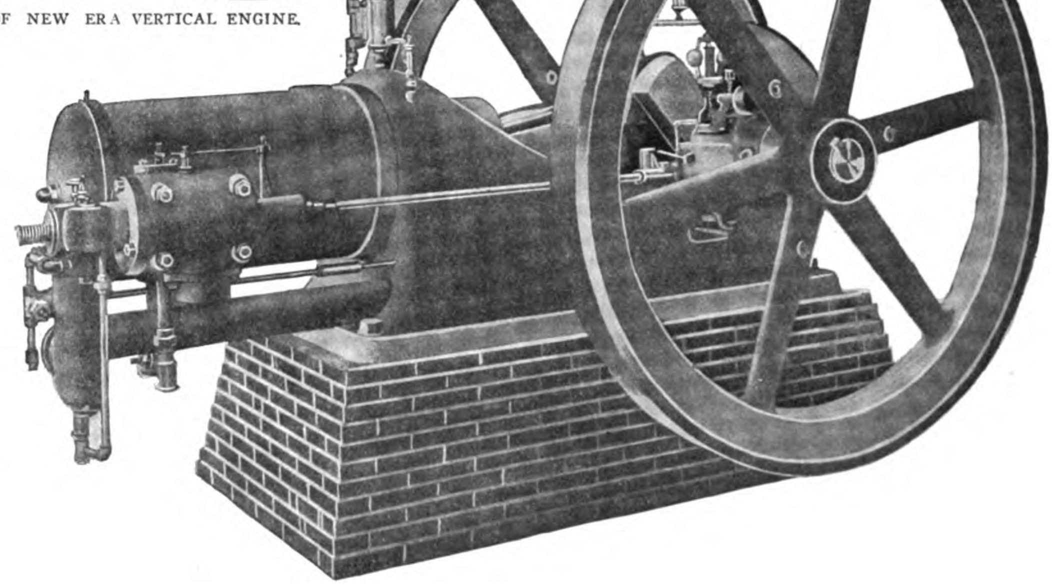

FIG. 34.—OLDS GAS ENGINE.

The engine is of the four-stroke-cycle type. As the first view of the engine shows, it is of very simple and massive construction. The crank-pin discs form the central portions of the flywheels, and the strain between the cylinder and the main bearings is resisted in a straight line by the sides of the engine bed. The bearings are of the self-oiling type, with chain oilers. The crank-pin is oiled through a straight duct of ample size, leading from a circular groove in the hub of one of the flywheels, to which groove oil is supplied by a sight-feed lubricator mounted on the cap of one of the main bearings.

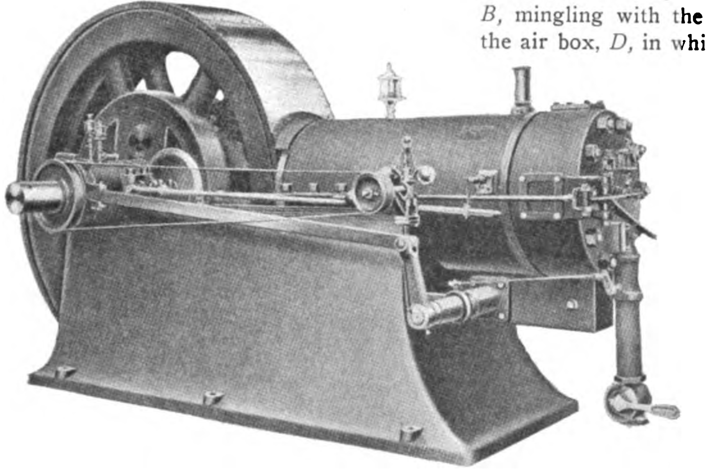

FIG. 42.—BRIGHTON GAS ENGINE.

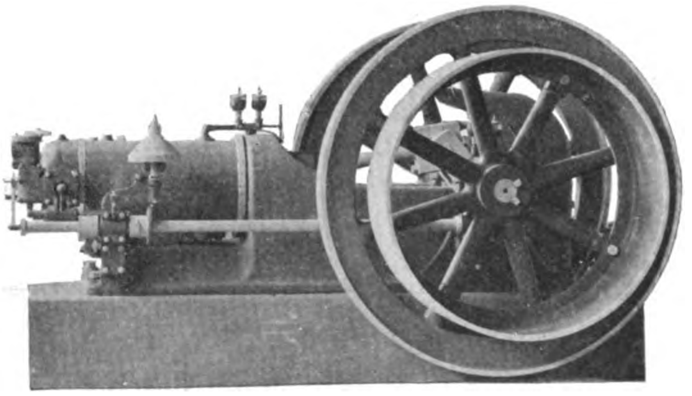

FIG. 39.—OTTO GAS ENGINE.

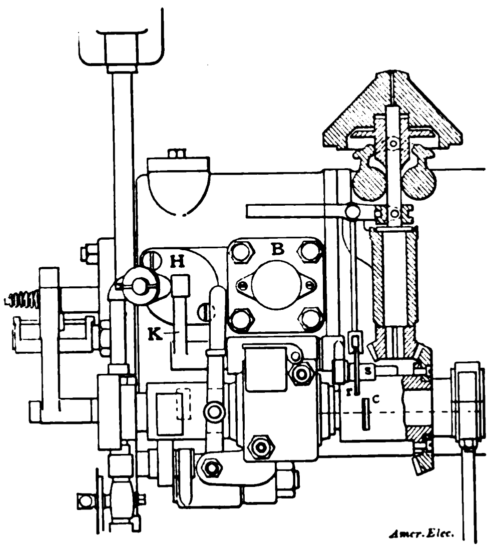

FIG. 41.—VALVE CHESTS OF OTTO GAS ENGINE.

The engine is provided with an auxiliary exhaust port, like the New Era, but the arrangement of valves is very unusual. The poppet valve, *A*, Fig. 45, which is opened by means of a rocker arm, shown in Fig. 44, serves the double purpose of admitting the charge and also releasing a part of the exhaust products. Most of the burned gases pass out through the main exhaust port, which is uncovered by the piston at the end of its forward stroke, as illustrated in Fig. 43. The remainder passes out at the valve, *A*, Fig. 45, and at this moment the piston valve, *C*, is in its lowermost position, so that the gases pass above it to the exhaust pipe. Fig. 45 shows the main piston and the valves during a charging stroke, when gas is admitted by the small poppet valve, *B*, mingling with the air supplied through the air box, *D*, in which the rocker arm, *F*, operates, and passing through the port of the poppet valve, *A*. During the return or compression stroke the valves, *A* and *B*, are, of course, closed, and it is immaterial where the positively-driven valve, *C*, may be. At the proper moment for exhaust, the valve, *C*, is drawn down low enough to connect the exhaust passage with the port of the poppet valve, *A*, and this valve is again opened, releasing that portion of the exhaust gases which did not pass out of the main port uncovered by the piston. The valves, *A* and *C*, therefore, perform the double function of admission and exhaust valves.

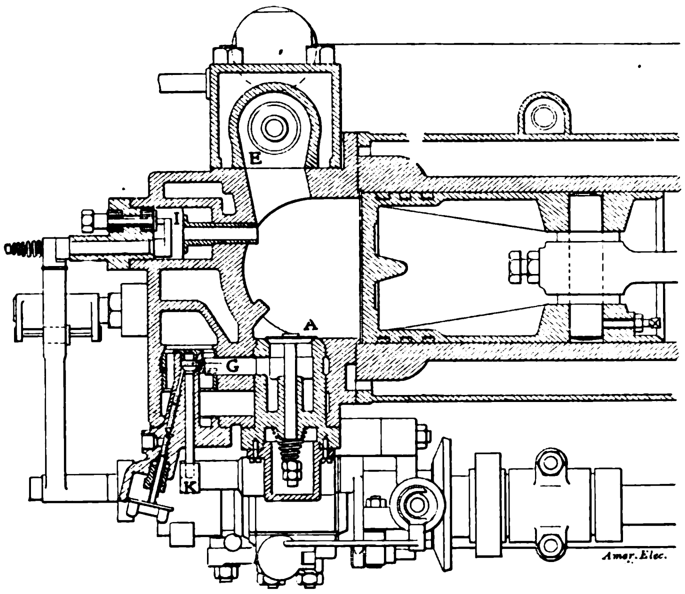

FIG. 40.—DETAILS OF OTTO GAS ENGINE.

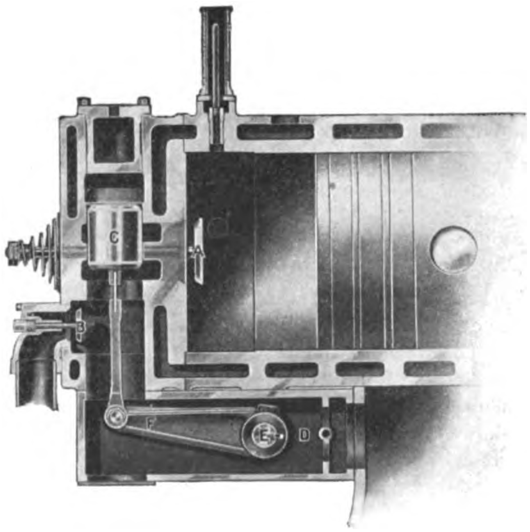

FIG. 45.—CYLINDER HEAD AND AIR BOX OF BRIGHTON GAS ENGINE.

The gas valve, *B*, is opened positively from the secondary shaft against the force of a spring as the piston starts forward on the charging stroke. The poppet valve, *A*, is opened from the same shaft, which is geared to the main shaft in the ratio of 1 to 2, as usual. The rock shaft, *E*, through which the piston valve, *C*, is driven, receives its motion, however, from an eccentric on the main shaft.

The larger sizes of this engine are equipped with either throttling or "hit-and-miss" governors. The "hit-and-miss" governor connects and disconnects the valve rod. The governor is of the ordinary flyball type, arranged to control two balanced butterfly valves, one in the air inlet and the other in the gas inlet. The electric igniter is of the butt contact type, the movable contact within the cylinder being mounted on a spindle to the outer end of which the flat spring, shown in the engraving, is attached. The igniter spindle is rocked by a beveled trip mounted on a reciprocating rod, which receives its motion from the secondary shaft. The ignition points are tipped with iridium. The trip, coming in contact with the spring, throws the points together, and they are snapped apart suddenly by the release of this spring when the trip has passed beyond its reach.

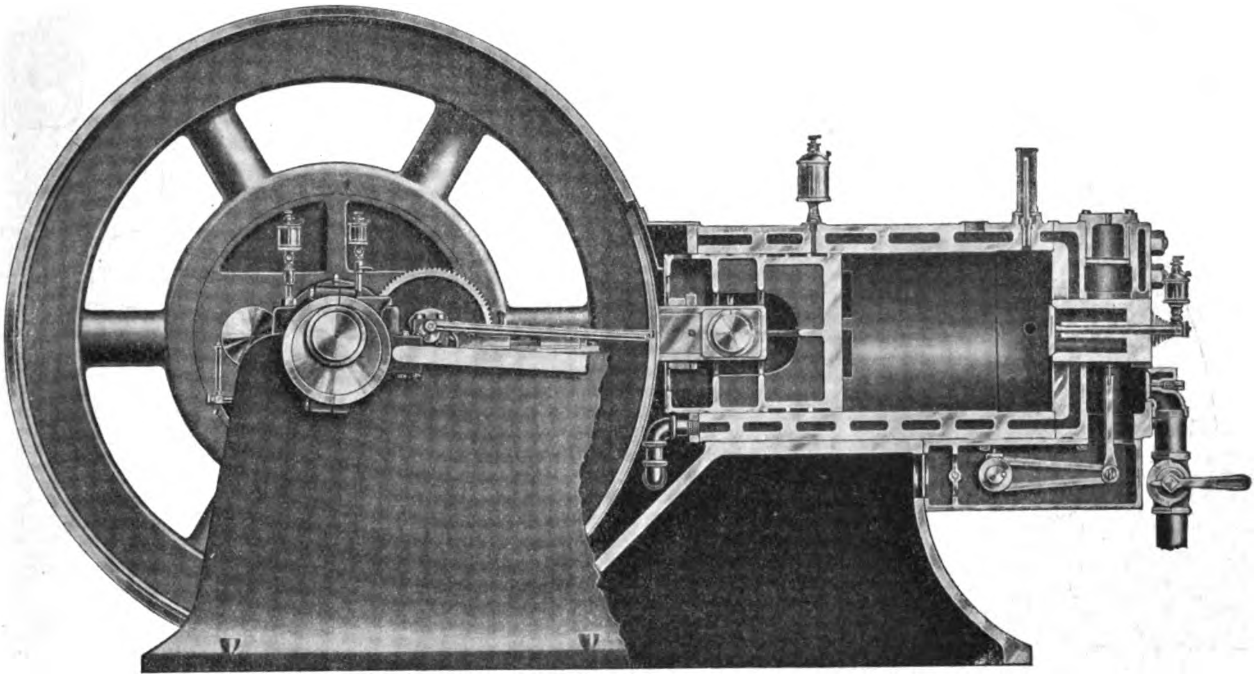
FIG. 43.—VERTICAL LONGITUDINAL SECTION OF THE BRIGHTON GAS ENGINE.

The automatic starting arrangement used in connection with this engine is interesting. The arrangement includes a small storage tank for compressed air, which is connected up to the cylinder of the engine through a special inlet. The pipe connecting the tank with the cylinder is provided with a small cup similar to the old-fashioned lubricator cups used on pumps and plain slide-valve engines many years ago. Before starting, about a spoonful of gasoline is poured into this cup, and the gasoline is delivered into the air-delivery pipe by turning the cock. A throw of the starting valve handle then admits a small quantity of compressed air to the connecting pipe, which vaporizes the gasoline and carries it into the cylinder, where it is ignited, giving the first impulse to the piston. This impulse is sufficiently strong to carry the piston through a complete double stroke, and the engine then begins its regular cycle of operations. One start, it is said, reduces the pressure in the air tank only a few pounds, so that a single filling of the tank suffices for several starts. To restore the pressure in the tank it is only necessary to shut off the gas supply from the engine, open the sealing valve between the cylinder and the pipe leading to the air tank, and raise the starting valve handle. The power stored in the flywheels is sufficient to recharge the air tank to the desired pressure.

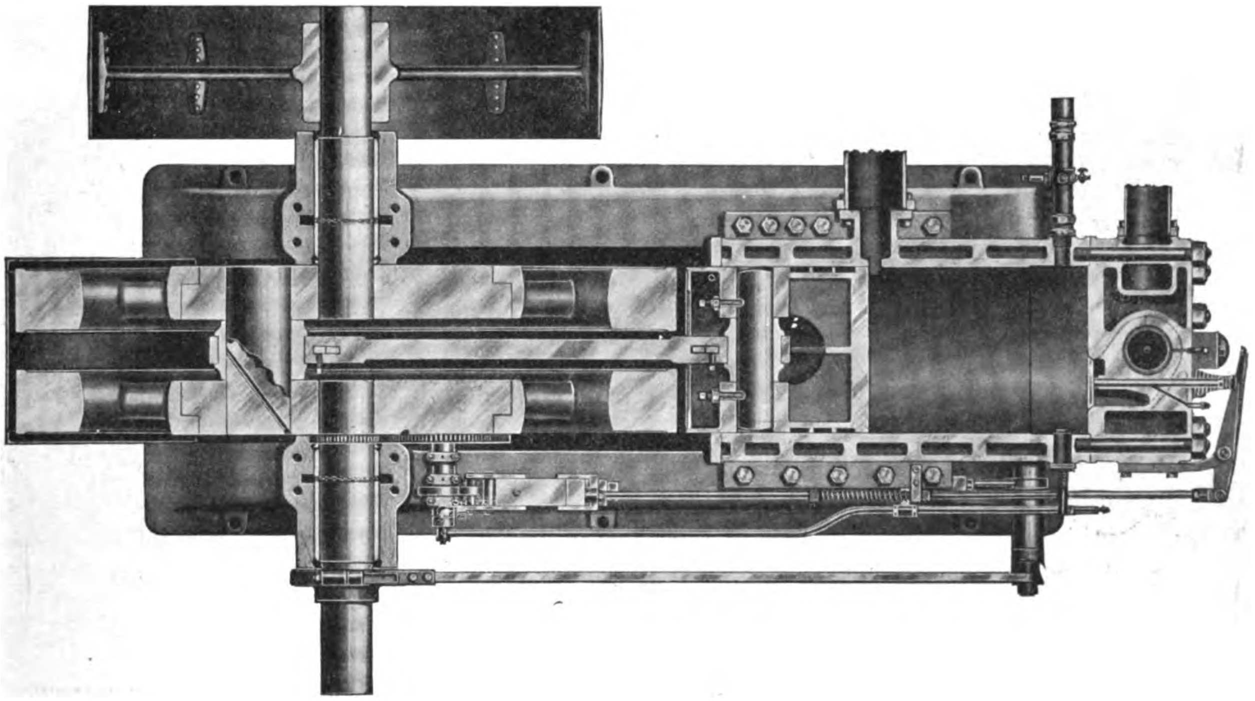
FIG. 44.—HORIZONTAL LONGITUDINAL SECTION OF THE BRIGHTON GAS ENGINE.

These engines are also built with an attachment for operation with gasoline, consisting of an adjustable mixing valve and a small pump operated from the engine shaft. No atomizer or carbureter is used, the gasoline being delivered directly into the engine cylinder.

Fig. 46 gives a rear view of the Advance engine built by the George D. Pohl Manufacturing Company, Vernon, N. Y. It happens that this engraving illustrates an Advance engine equipped for operation with gasoline, but as the only difference is a slight change in the arrangement of the mixer and the addition of the pump, the engraving will apply just as well to the gas engine. This engine is of the throttling class especially adapted for driving electric generators, and it operates on the usual four-stroke cycle. Fig. 47 is a sectional view showing the valve and governor arrangements. The admission valve, *A*, is opened by atmospheric pressure from without when the piston goes forward during the charging stroke; *B* is the starting valve, and *C* the regulating throttle valve controlled by the governor by means of the vertical arm *D* and the linkage, *H*. A detail of this linkage is shown to the right, giving a view of it from the side. The fuel enters through the small pipe, *G*. The exhaust valve, *E*, is opened by a rocker-arm pivoted beneath the cylinder and extending from the secondary shaft across to the exhaust valve stem, as shown in Fig. 46. The spaces marked *J* are, of course, the cooling water chambers, for which *I* is the inlet and *O* the outlet. The end of the secondary shaft is indicated in Fig. 47 by the letter *S*. The governor spindle revolves in a fixed position vertically, the external sleeve, *K*, being drawn up by the governor balls through the medium of the lifting collar, *Z*; the spring, *s*, opposes the action of the governor balls in the usual manner and the adjustment of its tension regulates the speed of the engine.

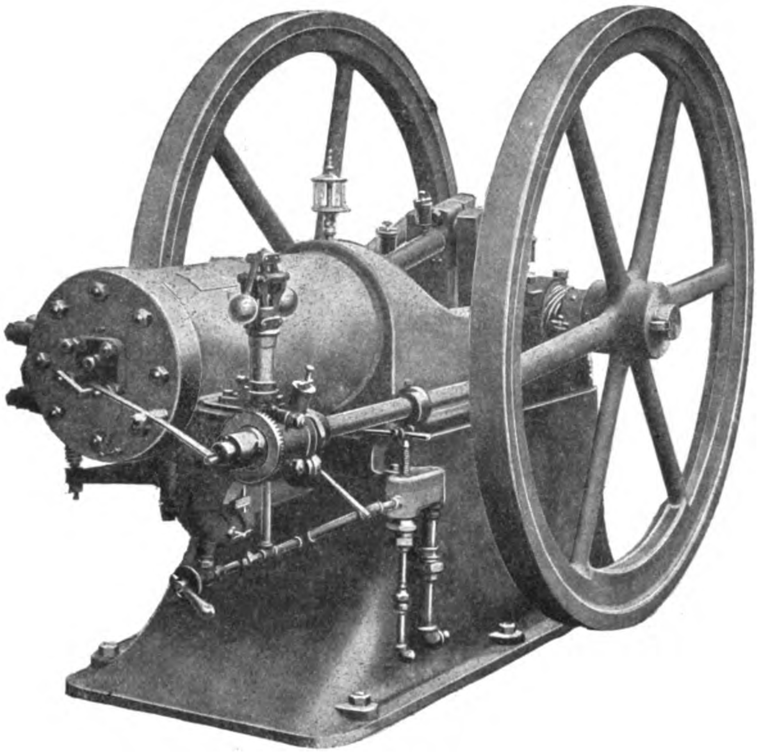

FIG. 46.—ADVANCE GAS ENGINE.

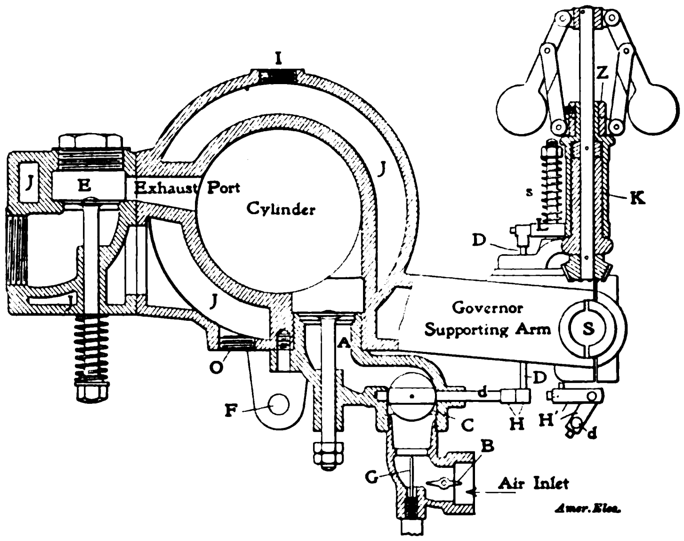

FIG. 47.—VALVE AND GOVERNOR ARRANGEMENT OF ADVANCE GAS ENGINE.

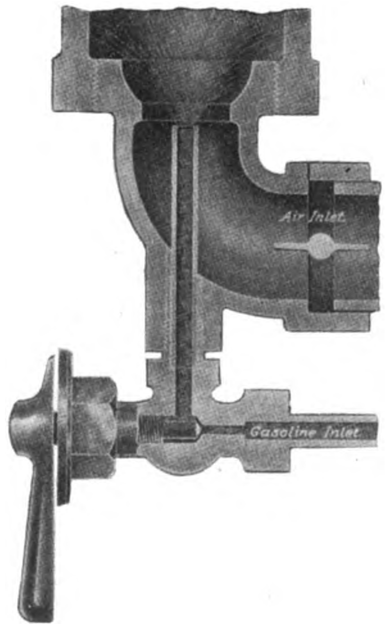

FIG. 49.—ADVANCE MIXER.

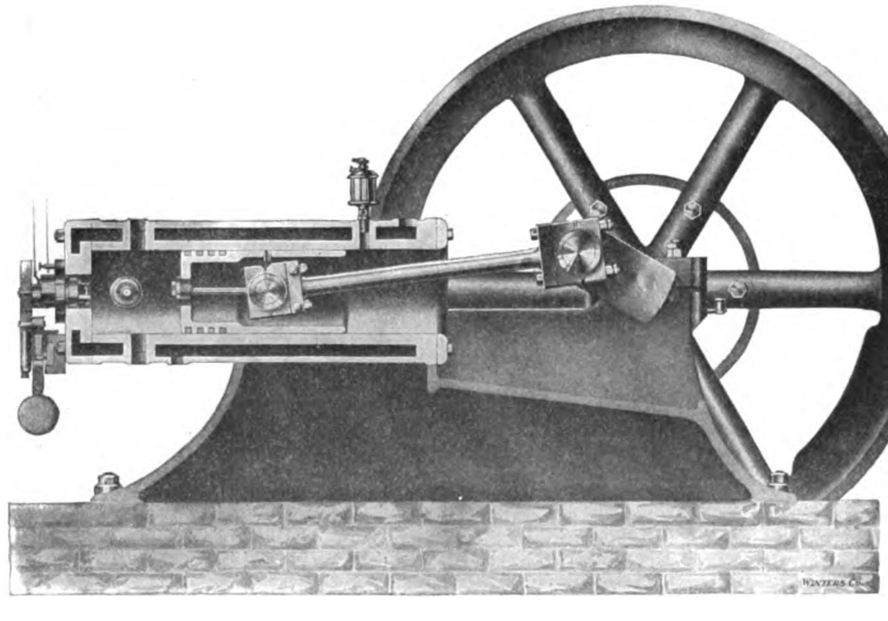

FIG. 50.—VERTICAL SECTION THROUGH CENTER OF SPRINGFIELD ENGINE.

The igniter is actuated by a spring lever and a pin cam on the secondary shaft, as shown in Fig. 46. Fig. 48 gives plan and end views of the igniter plug, which, it will be seen, is very simple and compact. The spring arm just referred to impinges against the pin in the end of the crank-arm mounted on the igniter spindle. The points of the igniter are made of platinum and may be unscrewed and replaced when necessary.

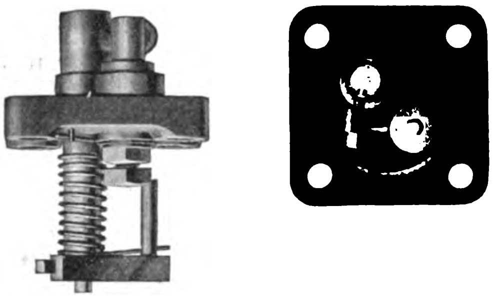

FIG. 48.—ADVANCE IGNITER PLUG.

When gasoline is used as fuel the mixing arrangement illustrated by Fig. 49 is employed. When the engine is at rest the gasoline fills the stand-pipe (which is indicated by *G* in Fig. 47) not quite level with the top, and when the engine is in operation the current of air drawn in by the suction of the piston draws the gasoline out of the stand-pipe in the form of spray. The quantity of gasoline is adjustable, of course, by means of the pin valve shown at the bottom of the mixer, to which it is delivered by the pump shown on the side of the engine base in Fig. 46.

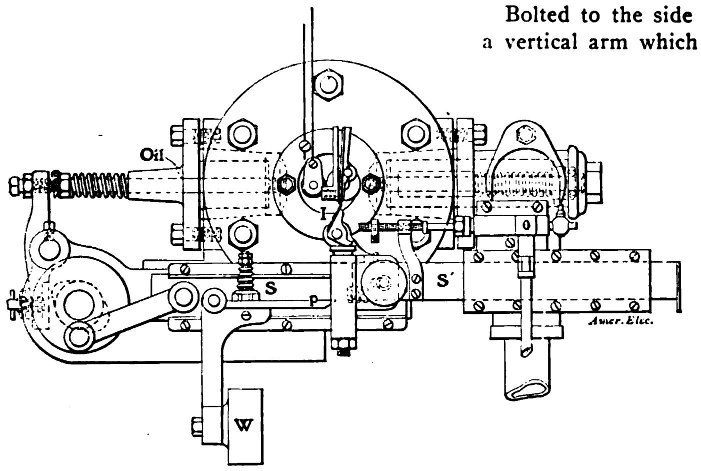

FIG. 52.—DETAILS OF SPRINGFIELD GOVERNOR, IGNITER AND GAS VALVE.

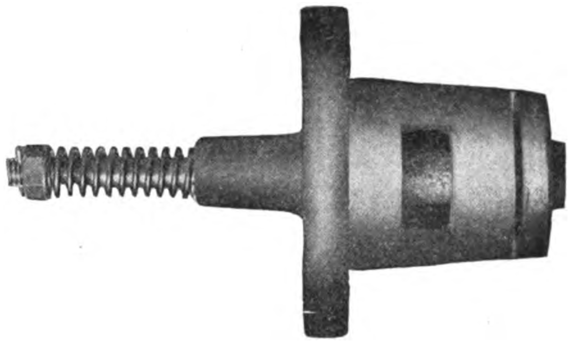

FIG. 53.—SPRINGFIELD VALVE.

The gas engine built by the Springfield Gas Engine Company, Springfield, Ohio, and illustrated by Figs. 50 and 51, is the only one of the group described in this article in which a centrifugal governor is not employed. This engine works on the four-stroke cycle, and is regulated by the "hit-and-miss" method. Fig. 52 is a rear view showing the details of the governor, igniter and fuel valve control, and while this view has a rather complicated appearance at first glance, the mechanism is really very simple.

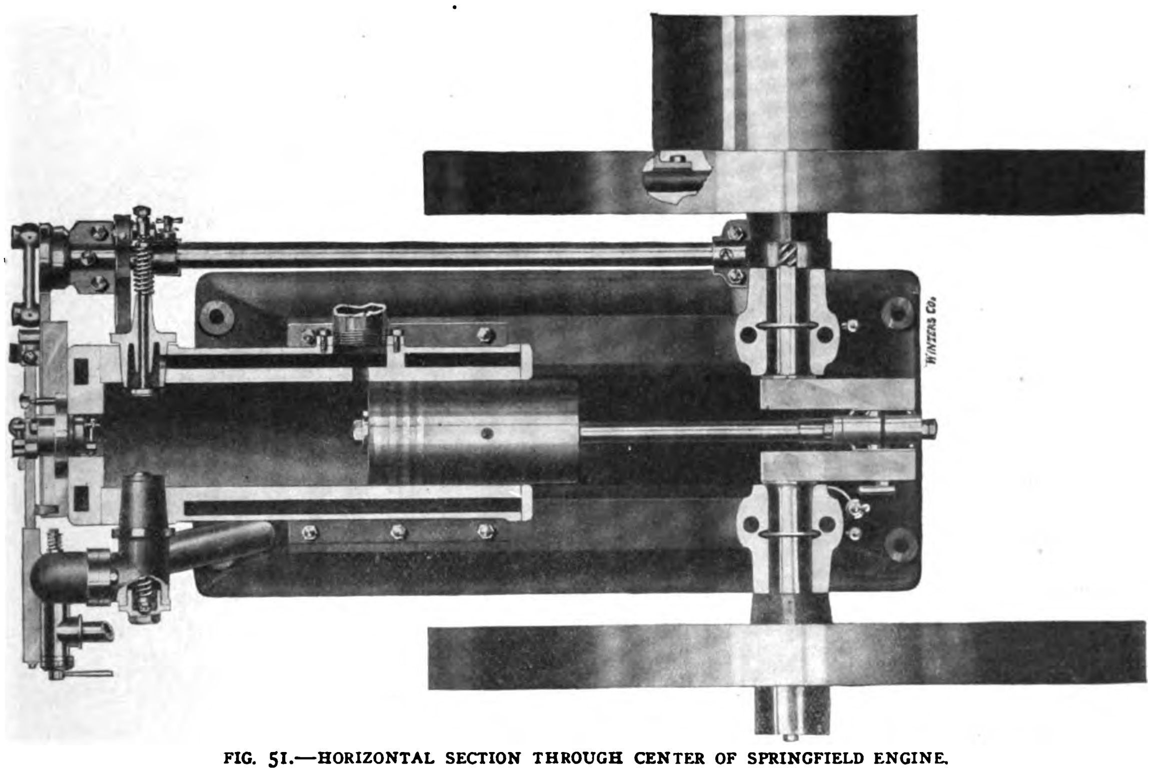

FIG. 51.—HORIZONTAL SECTION THROUGH CENTER OF SPRINGFIELD ENGINE.

The secondary shaft lies on the left-hand side of the engine, as shown in Figs. 51 and 52, and opens the exhaust valve through the medium of a cam and the rocker-arm shown on the extreme left in Fig. 52. On the end of the secondary shaft is a crank-disc; a pitman extends from the crank-pin to a wrist-pin on the slide, *S*. Pivoted on this slide is a bell crank to the vertical arm of which is bolted a weight, *W*, and to the horizontal arm a pick-blade, *p*. The end of this pick-blade is normally in alignment with a buffer block on the slide, *S'*.

Bolted to the side of this second slide is a vertical arm which is shown slightly offset in Fig. 52, and which engages at its upper end with the stem of the gas valve. At normal speed the end of the pick-blade, *p*, engages the buffer block over it, and the slide, *S*, moves to the right so that the slide, *S'* is similarly pushed over in the right-hand direction, opening the gas valve. The mechanism is such that when the slide, *S*, is drawn back by the secondary shaft it pulls the slide, *S'*, back with it. Any increase in speed above the normal rate causes the pick-blade, *p*, to be thrown downward on account of the inertia of the weight, *W*, so that the end of the blade misses the buffer block on the slide, *S'*, and the gas valve remains closed. The helical spring, shown just to the right of the letter *S* in Fig. 52, is for the purpose of adjusting the governor and thereby the rate of speed.

As Fig. 51 clearly shows, the main admission valve is mounted in the side of the cylinder, directly opposite the exhaust valve; it is opened by atmospheric pressure, so that when the governor cuts off the gas the admission valve is opened just the same and pure air admitted to the cylinder. The admission and exhaust valves are mounted in individual casings which are readily removable from the cylinder each in a single unit, as shown by Fig. 53. The valves are of the poppet type, of course, but instead of having beveled faces the faces and seats are flat, their plane being at right angles with the axis of the valve stem. This arrangement was adopted in order to facilitate regrinding and to give a larger area of opening with a given movement of valve. As in the case of two of the engines previously described, the Springfield engine has a second exhaust port near the front end of the cylinder, which is uncovered by the piston, as shown in Fig. 51. The main exhaust outlet is directly opposite this port, so that it is practically the principal exhaust port, rather than an auxiliary one. The port opened by the exhaust valve is more properly an auxiliary exhaust port, its function being merely to allow the residual products of combustion to be swept out by the piston on its back stroke after most of the burning and burnt gases have escaped by means of the forward port.

The igniter, *I*, Fig. 52, is actuated by a trip mounted on an arm bolted to the rear end of the slide, *S'*. The engraving shows the trip just in the act of operating the igniter; the rotational direction of the secondary shaft, viewed from the rear as in this engraving, is clockwise.

Fig. 54 illustrates the special electric light engine built by the St. Mary's Machine Company, St. Mary's, Ohio. Both the admission valve and the exhaust valve are positively operated by cams and rocker-arms. The engine is of the throttling class; a throttle valve in the mixing chamber on the left-hand side of the cylinder head being controlled by the governor through the horizontal rocker-arm pivoted to the face of the cylinder head. The ignition is electric, as the engraving clearly indicates, the usual butt-contact igniter being employed and actuated by a spring lever and a pin-cam on the end of the secondary shaft. This company also builds a line of "hit-and-miss" engines for general service in sizes ranging as high as 60 horse-power, but all engines of 75 horse-power and over are of the throttling type here illustrated. The valves, of course, are of the poppet type and are contained in individual valve cases, which may be removed without disturbing any other parts of the engine or any of its adjustments. This engine is adapted to use gasoline as well as gas, and it can be adapted to use kerosene or crude oil for fuel by the addition of a vaporizer, which is heated by the exhaust gases of the engine.

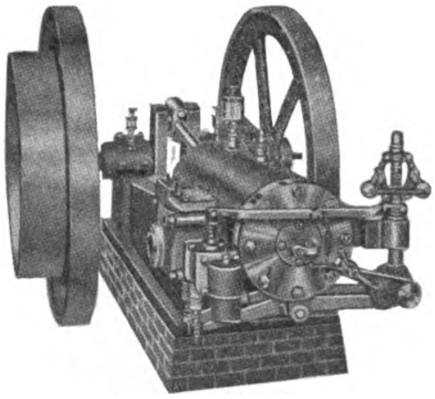

FIG. 54.—ST. MARY'S GAS ENGINE

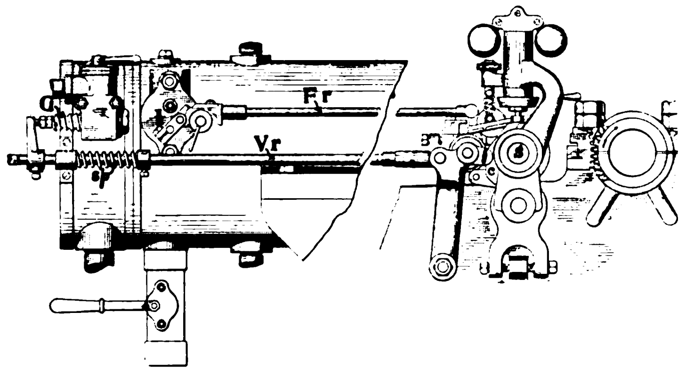

FIG. 55.—FT. WAYNE CONTROL MECHANISM.

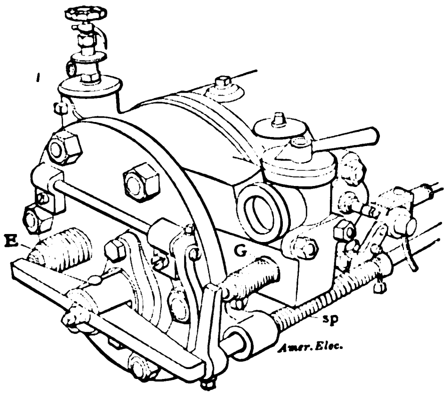

FIG. 56.—FT. WAYNE GAS ENGINE DETAILS.

Fig. 55 illustrates most of the control mechanism of the gas engine built by The Ft. Wayne Foundry & Machine Company, Ft. Wayne, Ind. This engine is of the four-stroke-cycle class, governed by the "hit-and-miss" method. Fig. 56 gives a diagonal view of the rear end of the cylinder and the mechanism mounted thereon, and Fig. 57 is a horizontal sectional view through the cylinder and the admission and exhaust valve chambers. The secondary shaft, *S*, Fig. 55, is a very short one, and lies parallel with the main shaft, which is shown just to the right of it in this engraving. The cam *c* on the secondary shaft throws to the left the rocker-arm to which the valve rod, *Vr*, is connected, and the spring *sp* returns the valve rod when the cam releases it. This rod opens the exhaust valve (*E*, Figs. 56 and 57) when it is thrown back by the cam, and opens the gas valve (*G*, Fig. 56) when released by the cam and thrown forward by the spring *sp*, this spring being much stronger than the seating spring on the gas-valve stem. The gas valve delivers fuel to the cage of the admission valve, *A*, Fig. 57, and this valve is opened by atmospheric pressure.

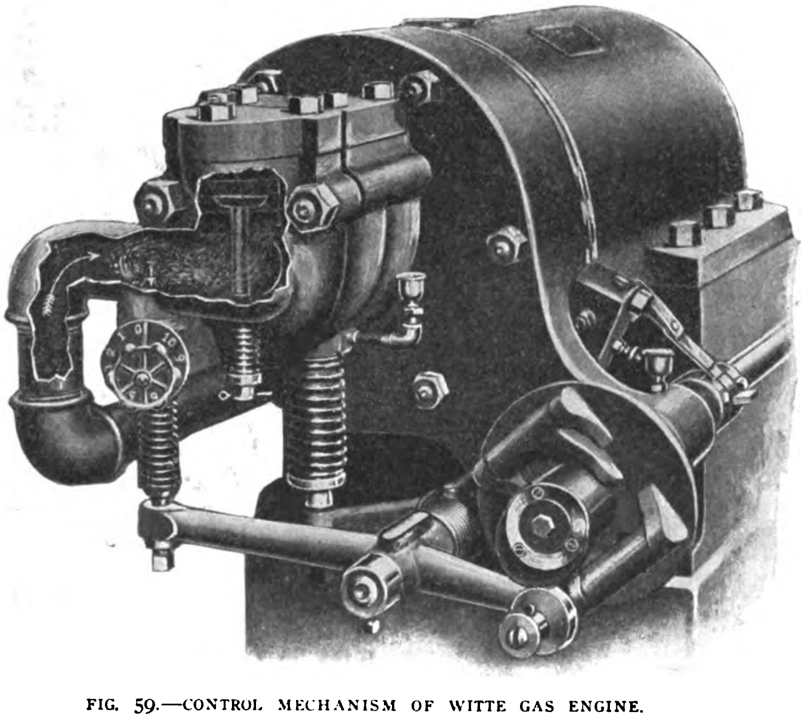

FIG. 59.—CONTROL MECHANISM OF WITTE GAS ENGINE.

During a normal charging stroke, the valve rod *Vr* is, of course, entirely released by the cam *c* on the secondary shaft so that it holds the gas valve open. During the compression stroke, the cam *c* holds the valve rod in an intermediate position where it releases the gas valve, but has not begun to open the exhaust valve. This position is, of course, maintained during the working stroke also, but at the end of that stroke the cam on the secondary shaft pushes the valve rod all the way back and thereby opens the exhaust valve. This cycle of actions goes on regularly so long as the speed is not excessive. Abnormally high speed

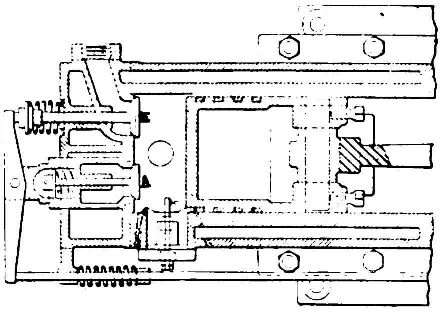

FIG. 57.—CYLINDER AND VALVE CHAMBER OF FT. WAYNE ENGINE.

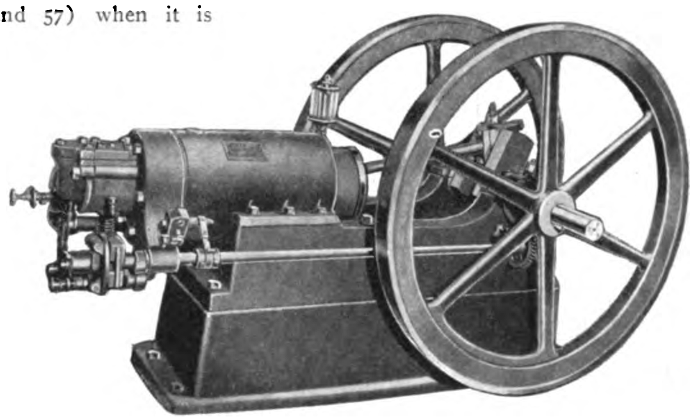

FIG. 58.—WITTE GAS ENGINE.

causes the governor to raise the end of a latch into interference with a lug on the rocker-arm to which the valve rod *Vr* (Fig. 55) is pivoted. This action holds the valve rod after it has been released by the cam on the secondary shaft and thus prevents the gas valve from being opened. The engine takes air through the admission valve during this idle stroke, as in the case of several of the other engines previously described.

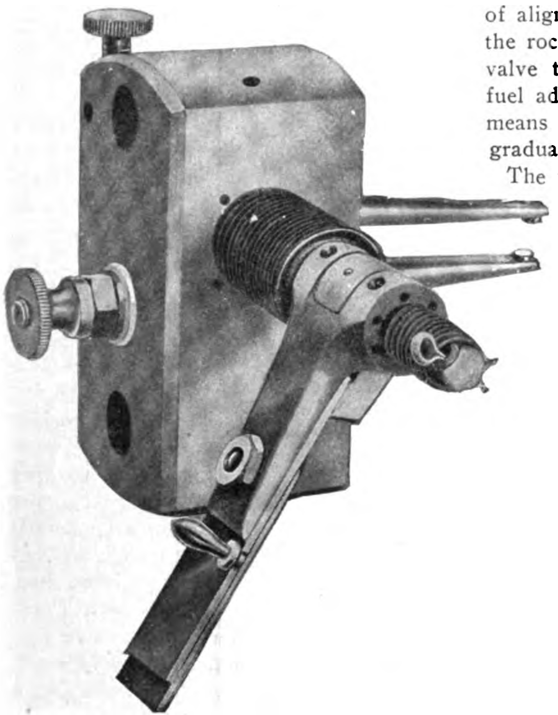

FIG. 60.—WITTE GAS ENGINE IGNITER.

The Witte engine, illustrated by Fig. 58, and built by the Witte Iron Works Company, Kansas City, Mo., has the very unusual qualification of being able to operate equally well with gas, gasoline, kerosene or distillate, without any change whatever in any of its parts; it also has the unusual feature of having its governor mounted directly on the secondary or cam shaft, and arranged to control the admission of fuel without the intervention of any mechanism beyond the rocker-arm which operates the gas valve. The engine works on the four-stroke cycle, and is regulated by the "hit-and-miss" method. Fig. 59 shows all of the control mechanism. The head of the governor is shown in the lower right-hand corner of the engraving. It caries the cam which actuates the rocker-arm of the gas or gasoline valve, and when the speed exceeds the proper rate it draws the cam out of alignment with the roller on the end of the rocker-arm and thereby allows the fuel valve to remain closed. The quantity of fuel admitted by this valve is adjusted by means of the hand wheel shown over the graduated plate near the air inlet pipe. The main admission valve is located between the fuel valve and the exhaust valve, and is opened by atmospheric pressure. It is shown lifted in the engraving. The exhaust valve is opened by a rocker-arm pivoted on the same stud with the fuel-valve rocker-arm and oscillated by a cam on the secondary shaft between the governor and the shaft bearing.

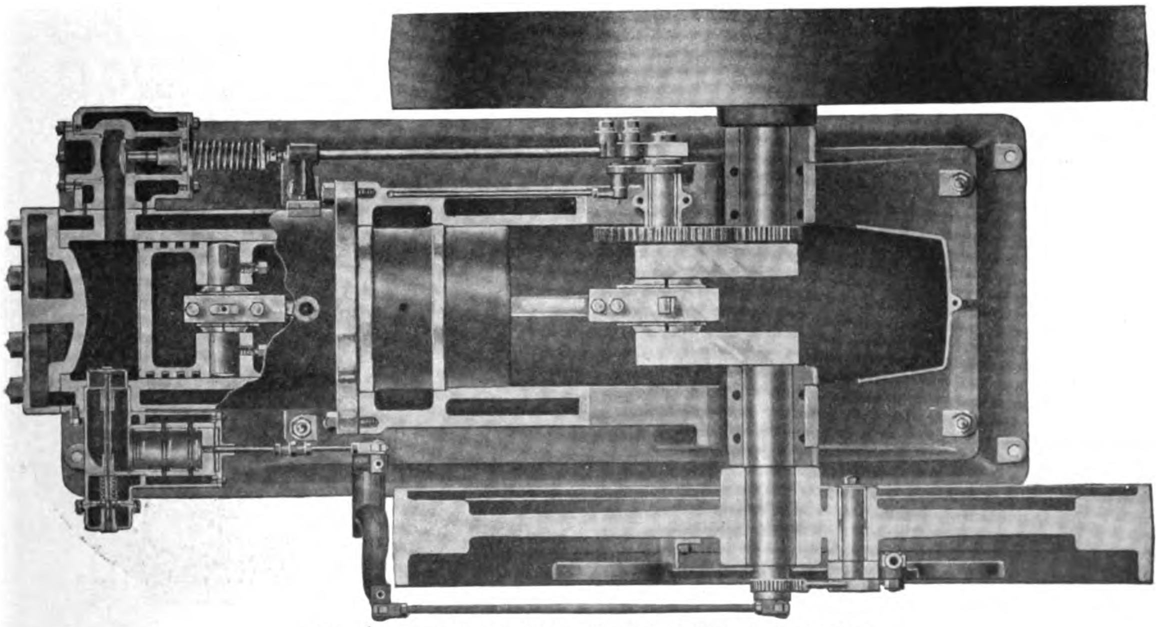

FIG. 61.—SECTIONAL VIEW OF THE BURGER GAS ENGINE.

As both of the engravings indicate, the valve and mixing chamber is in two parts, one of which is cast integral, with the cylinder head and the other bolted on; the fuel and admission valves are contained in the removable part and the exhaust valve is mounted in the part which is integral with the cylinder head. Each part is provided with a removable cap, as shown in Fig. 59, so that access to any of the valves is possible without removing the outer half of the valve chamber.

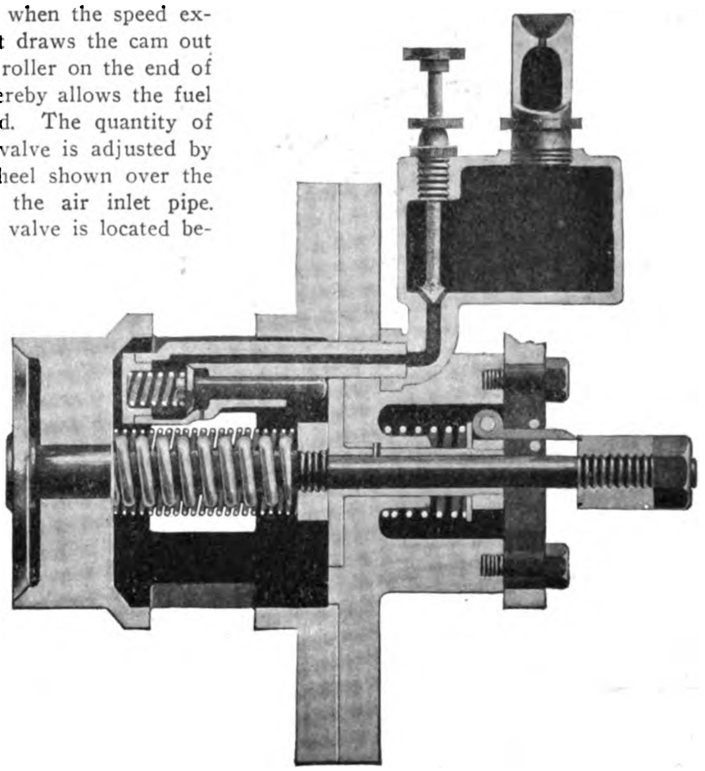

FIG. 63.—BURGER AIR AND GASOLINE VALVES.

The igniter is of the butt-contact type, operated by a spring arm, one end of which is attached to the igniter spindle; the other end is lifted by the flat pin cam shown in Fig. 59 beyond the cam-shaft bearing.

The spring arm of the igniter is of composite construction. Referring to Fig. 60 it will be evident that this arm is composed of two thin plates (of steel) bolted to a lug projecting from the hub. The bottom plate of these two is longer than the upper one, and is pivoted on the bolt shown in the end of the lug. For starting up, this bottom plate is left in the position shown in Fig. 60, with its end projecting beyond the end of the upper plate. The cam on the secondary shaft, therefore, cannot release the igniter arm until it has gone far enough to allow the end of the long plate to snap back. This times the ignition so that the charge cannot explode before the crank passes the inner dead center. After the engine has been started up, the longer plate of the igniter arm is thrown outward by means of the small handle shown, so that the cam engages with the shorter spring plate, and releases the igniter contacts earlier.

The Burger automatic engine, illustrated by Fig. 61, and built by the Woolley Foundry & Machine Works, Anderson, Ind., has the distinction of being the only one, so far as the writer's knowledge extends, on which the Rites governor is used. Fig. 62 shows the governor wheel. The weights oscillate a small rack about the pivot on which the weight arm is hung, and this rack meshes with a gear on a little crank disc, the crank-pin of which gives a reciprocating motion, by means of rods and rocker-arms, to a valve determining the quantity of explosive mixture admitted to the cylinder chamber. At maximum load the ports are open during the entire charging stroke, and at loads less than maximum the supply is cut off before the completion of the charging stroke, the point of cut-off varying according to load requirments, the quality of the charge being unaffected by the governor.

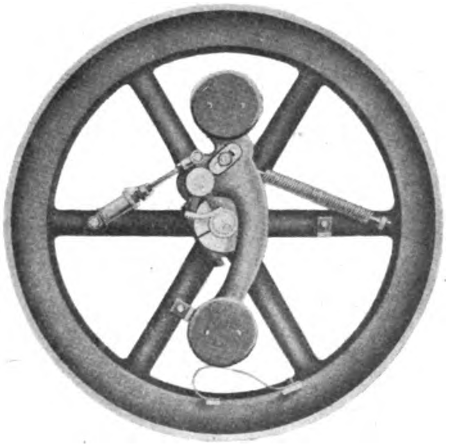

FIG. 62.—GOVERNOR OF BURGER GAS ENGINE.

The secondary or cam shaft is on the opposite side of the cylinder from the governor, and controls the exhaust valve and the igniter in the usual manner. Inspection of Fig. 61 will show that the exhaust-valve chamber is provided with a removable cap or bonnet opposite the valve to facilitate during each charging stroke of the piston. This valve is of the multiported piston type, and is shown clearly in Fig. 61. The two right-hand rows of ports control the air admission to the mixing chamber and the third row controls the gas admission. The main admission valve is mounted at right angles to the governing valve, and opens directly into the cylinder. It is opened by atmospheric pressure. The governor operates to vary the length of time the regulating valve ports are open to the mixing the removal of the valve, the valve seat being integral with the valve chamber housing.

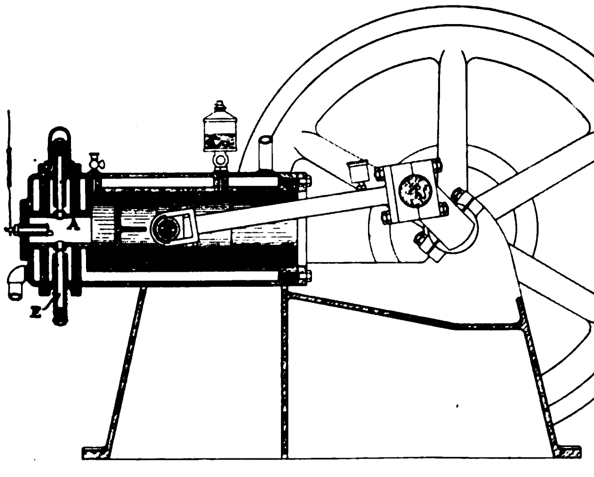

FIG. 64.—COOK GAS ENGINE.

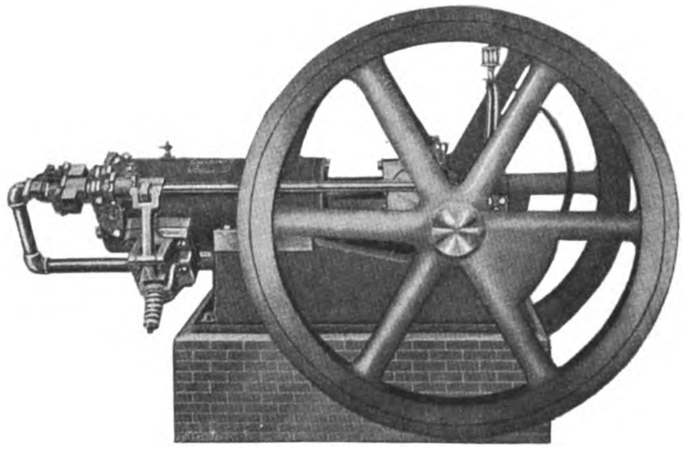

FIG. 65.—MIAMI GAS ENGINE.

The Burger engine is also built on the "hit-and-miss" plan. The gas valve has a hollow stem, and is mounted on the stem of the main admission, or air, valve. The hit-and-miss regulation button on the end of the main valve stem normally engages a pick-blade pivoted on the end of the gas valve stem so that the two valves are opened in unison; excessive speed causes the governor, which is of the centrifugal variety, but mounted on the main shaft, like the Charter governor, to swing the pick-blade out of alignment with the button on the air-valve stem, allowing the air valve to open and leave the gas valve closed. A somewhat similar arrangement is employed in the Burger gasoline engine.

Fig. 63 shows the arrangement for gasoline. The fuel is delivered to the fuel valve past a small regulating valve, shown in the upper part of the engraving. The fuel valve is opened by a collar on the stem of the admission valve, this collar being pushed forward by the button on the admission-valve stem engaging with the pick-blade pivoted on the rear end of the collar. The pick-blade reciprocates between two studs set in a slide controlled by the governor; excessive speed causes the governor to raise this slide (as the parts are shown in the engraving) and pull the pick-blade out of reach of the button. The builders do not recommend hit-and-miss control where close regulation is required.

The engine of the Cook Manufacturing Company, Albion, Mich., is illustrated in section by Fig. 64. This is a "hit-and-miss" engine operating on the usual four-stroke cycle. The admission and exhaust valves are practically alike, and are mounted in removable cages, as indicated in the engraving. The admission valve is opened by atmospheric pressure and the exhaust valve by a rocker-arm at right angles with the cylinder bore and pivoted beneath the cylinder. The end of the rocker-arm next to the secondary shaft (which is parallel with the cylinder and bed) is depressed by a cam on the shaft, and when the speed rises above normal the governor swings a finger over a projection on the end of the rocker-arm which catches the arm in the "open" position and holds the exhaust valve open during the charging stroke. The cylinder being kept open to the atmosphere, there is no difference of pressure to open the admission valve, and the charge is omitted. The governor is of the simple "fly-ball" variety, located above the exhaust-valve cam and gear-driven from the secondary shaft.

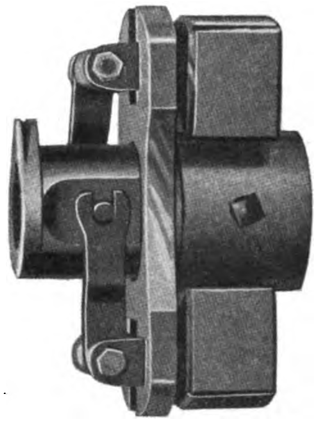

FIG. 66.—MIAMI GAS ENGINE GOVERNOR.

This engine has the unusual feature of a cylinder head integral with the cylinder. There is a relatively small circular opening in the back end of the cylinder, which is closed by the flange of the igniter plug; the remainder of the rear wall is integral with the cylinder barrel.

Fig. 65 illustrates the Miami gas engine, built by The Middletown Machine Company, Middletown, Ohio. As in the case of the Witte engine, the governor is mounted directly on the secondary shaft and its spindle carries the cam which opens the fuel valve, as shown by Fig. 66, which gives a view of the governor alone. The air and exhaust valves are opened by means of the usual cams on the secondary shaft, and each is mounted in a cage which is detachable from the cylinder. Fig. 67 shows the air valve and its cage. It will be noticed that a bell-crank lever is interposed between the valve-stem and the cam, the latter (not shown) acting against the roller carried by the bell-crank. The object of this arrangement is to obviate side strains on the valve stem and consequent unsymmetrical wear of the guide plates, which would allow the valve to seat improperly and tend to produce back-firing. The exhaust-valve bonnet and rocker-arm are shown in Fig. 65 very clearly. The rectangular governor weights also show plainly just beyond the end of the cylinder. The igniter cam appears a little to the left of the exhaust-valve cam; ignition is electric.

It will be noticed by reference to Fig. 65 that the weight for counterbalancing the crank and reciprocating parts is cast in the fly-wheel, between two spokes and near the center. It is stated that the center of gravity of this weight is the same distance from the center of the crank-shaft as that of the cranks, and that more nearly perfect balancing is thereby obtained. This engine is also adapted to operate on gasoline or distillate.

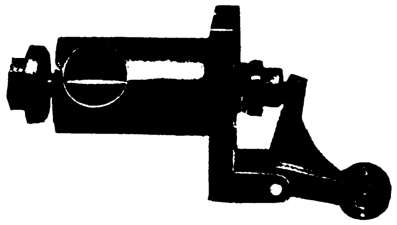

FIG. 67.—AIR VALVE, MIAMI ENGINE.

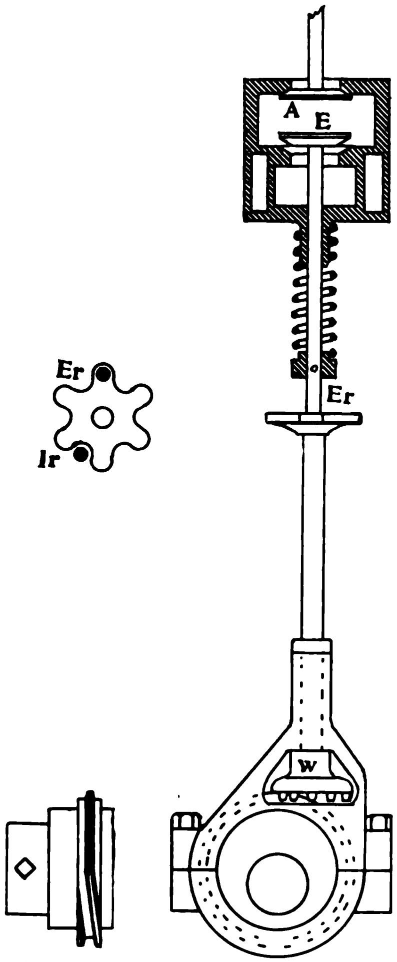

FIG. 69.—MEAD EXHAUST VALVE AND IGNITER GEAR.

The engine shown by Fig. 68 differs from every other one described in this article in that the charge is ignited by a Bunsen tube. Electric ignition is provided by the builders when desired, but their own preference is for the incandescent tube method. The short secondary shaft parallel with the crank shaft is used, and this merely actuates the exhaust valve; the admission valve is opened by atmospheric pressure so long as the speed is normal, and the fuel is delivered from the supply pipe directly to the admission valve chamber without the intervention of a fuel valve. The proportion of fuel to air is regulated by means of a hand valve, as is customary in all gas engines. The admission and exhaust valves are set in opposite ends of a single chamber, and the exhaust-valve stem is pressed back by a slide, which is reciprocated by an eccentric on the secondary shaft. There are no cams, rocker-arms or other moving parts besides those just enumerated, and the governor, which is of the pendulum type similar to that described in connection with the Springfield engine. The action of the governor is different from that of the Springfield engine, however, in that it swings a latch in front of the exhaust-valve stem when the speed rises, this latch holding the exhaust valve open and preventing the difference between the pressure in the cylinder and that of the atmosphere which normally operates the admission valve during the charging or "suction" stroke. This engine is built by the Utica Gas Engine Works, Utica, N. Y.

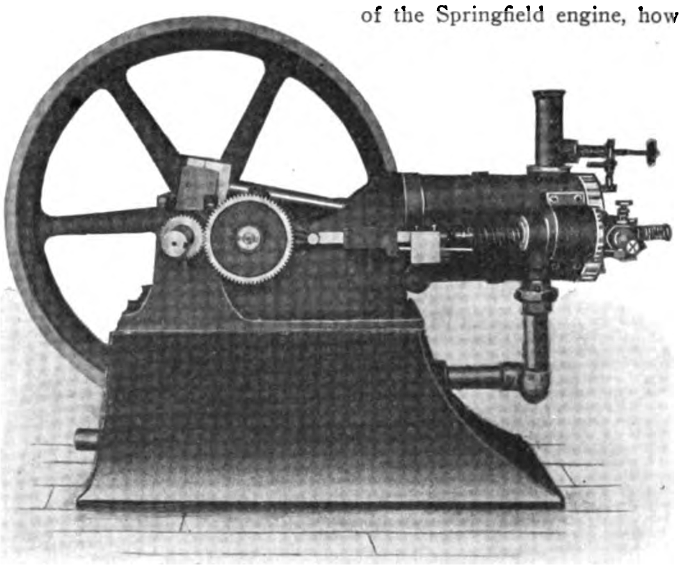

FIG. 68.—UTICA GAS ENGINE.

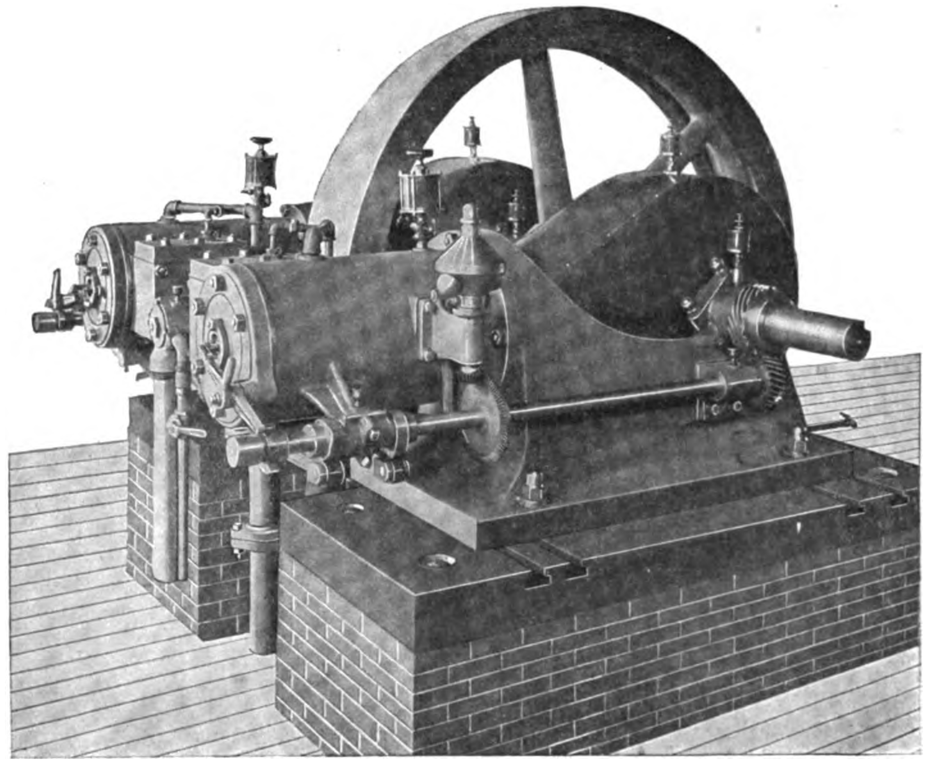

FIG. 70.—RUGER TWIN GAS ENGINE.

Fig. 69 illustrates a very ingenious method employed by the Mead Gas Engine Company, Providence, R. I., for operating the exhaust valve and igniter of an engine working on the four-stroke cycle, without using a secondary shaft. An eccentric on the crank-shaft reciprocates an eccentric rod in the usual manner, but the rod is twisted through one-twelfth of a revolution about its axis at each revolution of the crank-shaft by means of a crown wheel, *w*, mounted on the end of the eccentric rod and engaging with a partly spiral thread or web around the hub of the eccentric. This web is shown by the detail sketch at the left of the eccentric. The other end of the eccentric rod carries a star wheel which rotates with the rod, so that one of its teeth impinges against the end of the exhaust valve stem at the end of the working stroke of the piston but misses it at all other strokes. The star wheel similarly engages with the igniter rod at the proper time, and is rotated out of alignment with it when ignition is not required. The exhaust-valve stem or rod is indicated by *Er* and the igniter rod by *Ir* in the sketch.

Fig. 70 illustrates a twin gas engine for electrical service, built by the Ruger Manufacturing Company, Buffalo, N. Y. This machine is of the throttling type and works on the four-stroke cycle. The valves of the engine are, of course, of the poppet type, and are set vertically. Both valves are operated positively from the secondary shaft and the igniter, which is of the usual butt-contact type, is, of course, operated by a cam on the same shaft. It is stated that the valves are cushioned so that they close noiselessly. The mixture of gas and air is proportioned in the usual way, by means of a hand valve, and the governor controls the quantity of mixture admitted to the cylinder during each charging stroke. In the case of twin-cylinder engines, such as the one illustrated here, one throttling valve controlled by the governor regulates the quantity of mixture admitted to both cylinders, although each cylinder has an independent mixing valve, and independent exhaust valves of course are used. The admission and exhaust valve cams for the near cylinder are shown one on each side of the journal bracket of the secondary shaft in the engraving. The governor, as the engraving clearly shows, is of the familiar fly-ball type. In a recent test of a 20-h.p. twin-cylinder engine speeded at 252 r.p.m. under full load, the speed of the engine with three-quarter load was 255 r.p.m., with half load 257 r.p.m., and no load 259 r.p.m.

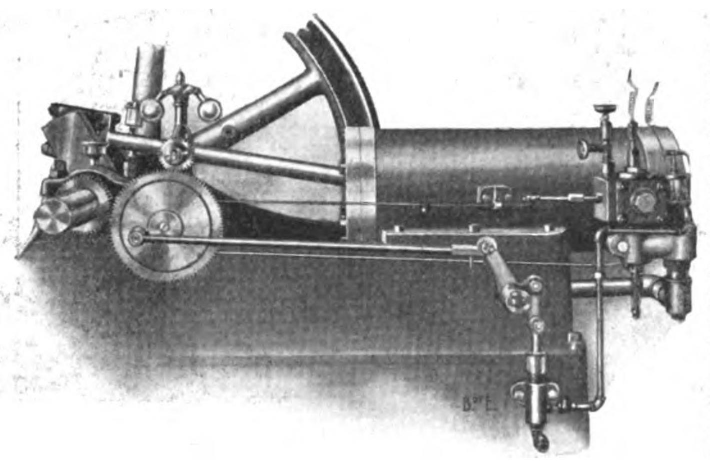

FIG. 71.—WHITE GASOLINE ENGINE.

Oil Engines.

Most of the gas engines described in the foregoing part of this article are adaptable to work with gasoline as fuel, and some of them may be worked on distillate, as mentioned in the course of the descriptions. There is, however, a distinct class of internal combustion engines designed especially to work with oil as fuel, and although the number of such engines is relatively very small, it has been deemed preferable to separate the descriptions of them from those of the gas engines proper.

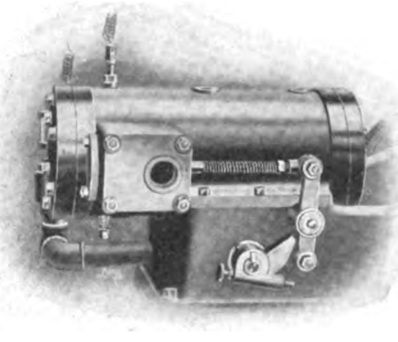

FIG. 72.—WHITE EXHAUST MECHANISM.

The White engine, the constructional features of which are illustrated by Figs. 71, 72 and 73, is built by The Globe Iron Works Company, Minneapolis, Minn., for operation with gasoline as fuel. It is made with both "hit-and-miss" and throttling regulation, according to the character of the service to be performed. The builders have the frankness to say that the throttling regulation is less economical when running with loads below one-half the normal or thereabouts, but the "hit-and-miss" regulation does not give as nearly uniform rotation as the other method, and is no more economical with loads considerably above half-load than the throttling method of regulation, while the wear and tear on the engine is probably a little greater than when throttling is employed. For electric light service, the throttling engine is furnished, naturally.

This engine has the short secondary shaft and plain spur gears described in connection with several of the gas engines. The pitman shown extending back from a crank-pin on the secondary gear in Fig. 71 oscillates a rock-shaft which passes transversely through the engine base and carries on its other end a cam for operating the exhaust valve. The bell-crank at the end of the rock-shaft, visible in Fig. 71, actuates the pump by which gasoline is delivered to the sight-feed reservoir shown in Fig. 73. When the rock-shaft draws the plunger of the pump up, the cam on the other end opens the exhaust valve. This cam and its relation to the exhaust-valve rocker-arm are shown by Fig. 72. A point claimed for this latter arrangement is that the exhaust valve can be so adjusted for starting the engine that there is no "hard" point to overcome in turning the flywheel over by hand, and consequently no danger of the attendant being thrown down by having to exert excessive strength at one moment and having the strain released unexpectedly the next. This, it is stated, makes auxiliary starting apparatus unnecessary, even for large sizes of engine.

Fig. 73 shows the mixer and the arrangement of the igniter points within the admission port. The admission valve is opened by atmospheric pressure. The movable igniter electrode is reciprocated by a cam on the secondary shaft, and is unusual in character; it is merely a black machine-steel pin, and is pushed into rubbing contact with the point of the stationary electrode, which is a similar pin. The rate at which the gasoline is fed to the cylinder is determined by the adjustment of the needle valve in the center of the sight-feed cup, Fig. 73, except for the intervention of the governor, which regulates the engine speed by varying the quantity of oil taken into the cylinder at each charge. The oil passes down from the sight-feed cup to the vaporizer, which is heated by the exhaust gases, and thence it is drawn into the cylinder along with the inrush of air when the piston "sucks" the admission valve open. In the "hit-and-miss" White engine, the governor operates to hold the exhaust valve open during the charging stroke, so that the pressure on opposite sides of the admission valve is equalized and the valve remains closed. It is quite conceivable that these engines could be operated equally well with gas for fuel by omitting the pump and sight-feed, and delivering gas to the admission-valve cage, unless the compression might not be suitable for efficient performance.

An oil engine built to use plain kerosene, crude petroleum, or the so-called "fuel" oil is shown by Fig. 74. This is the Hornsby-Akroyd engine, built in this country by the De La Vergne Refrigerating Machine Company, New York. It is radically different

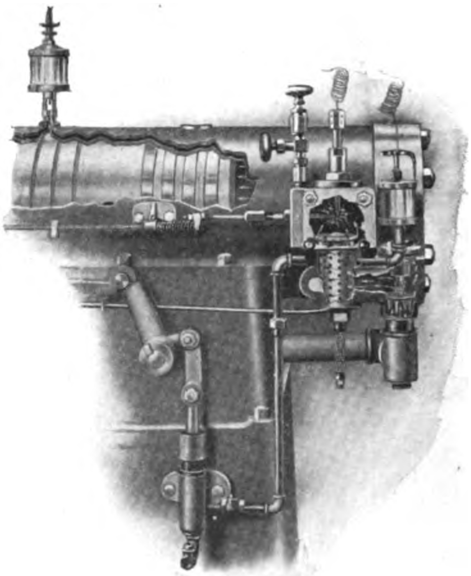

FIG. 73.—MIXER AND IGNITER ARRANGEMENT.

in several respects from any gas or gasoline engine. Back of the cylinder and opening into it through a contracted neck is a vaporizing and combustion chamber, into which oil is injected by a pump during the charging stroke; at the same time an air valve is opened by the same cam which actuates the pump plunger, and air is drawn into the cylinder (not the vaporizing chamber). On the return stroke of the piston the air is forced into the vaporizing chamber, where the charge of oil has been vaporized, and the mixed oil vapor and air are compressed to the temperature required to ignite the mixture. The explosions keep the vaporizing chamber at the proper temperature for vaporizing the oil when it is injected by the pump. After the working stroke of the piston is finished, the exhaust valve is opened by a cam and rocker-arm, as in the case of many of the gas engines described. The rocker-arms which open the air and exhaust valves are close together, as shown in Fig. 74. The governor regulates the speed of the engine by controlling the quantity of oil delivered by the pump.

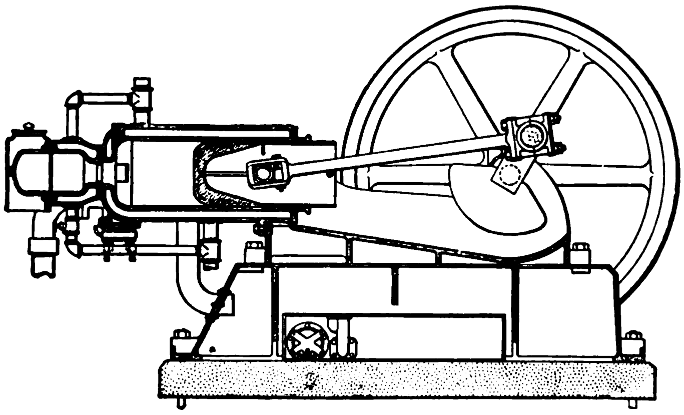
FIG. 75.—SECTIONAL VIEW OF HORNSBY-AKROYD OIL ENGINE.

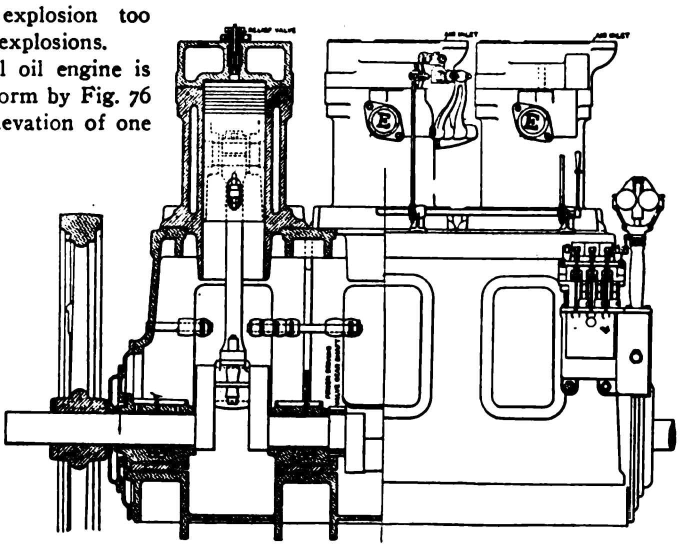
FIG. 76.—SEMI-SECTIONAL VIEW OF DIESEL OIL ENGINE.

Fig. 75 shows the arrangement of the cylinder and vaporizing chamber; the rear half of the latter is housed by a hood to protect it from drafts of air and keep up its temperature, while the front half is water-jacketed, like the cylinder. This engraving shows the contracted opening between the vaporizer and the cylinder. It has been stated by some authorities that the size of this opening has a very important bearing upon the operation of the engine, too small or too large an opening making an engine entirely inoperative by reason of either choking or localizing the explosion too much or causing premature explosions.

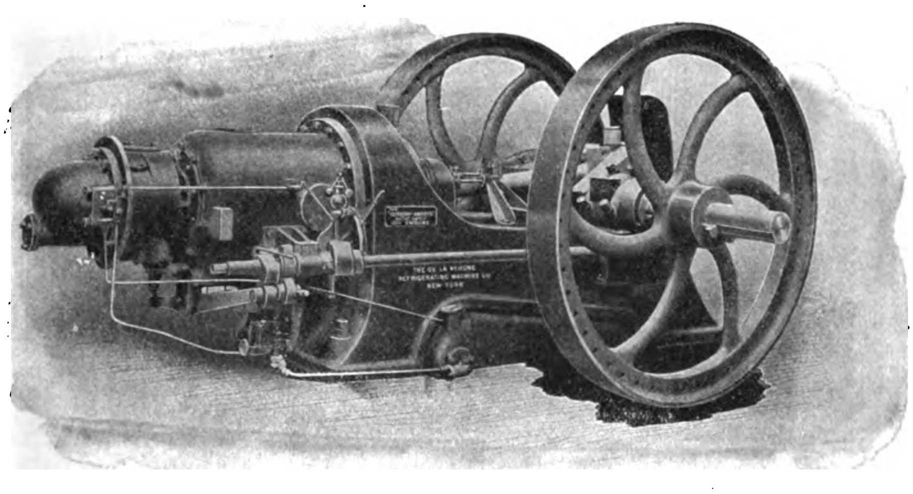
FIG. 74.—HORNSBY-AKROYD OIL ENGINE.

The now celebrated Diesel oil engine is represented in two-cylinder form by Fig. 76 and Fig. 77, is a sectional elevation of one cylinder. As indicated in the latter engraving, the secondary shaft is located within the crank housing and parallel to the crank-shaft, from which it is driven through an intermediate gear, as in the case of the Marinette gas engine. The secondary shaft opens the fuel valve and the exhaust valve at the proper moments by the usual cam and reach-rod arrangement and the valve which admits air opens automatically under atmospheric pressure. The arrangement of the valves is shown by Fig. 78. The fuel valve is of the needle type, and is surrounded by brass washers which break the oil up into fine particles; two pipes are shown leading into the fuel valve cage; one of these delivers oil and the other compressed air by means of which the oil is literally blown into the cylinder. The action of the engine, which works on the usual four-stroke cycle is as follows:

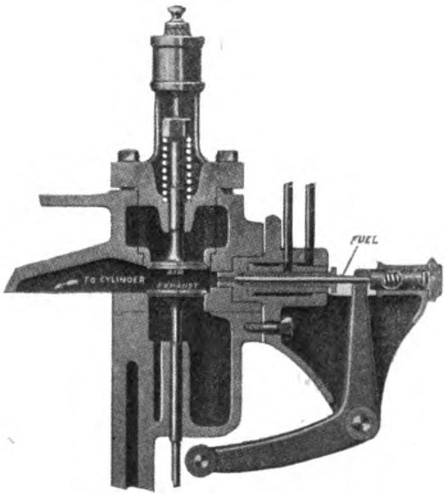

FIG. 78.—ADMISSION VALVE, DIESEL ENGINE.

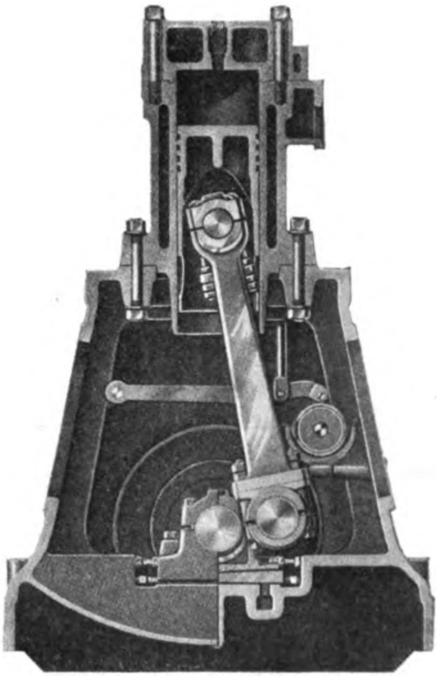
FIG. 77.—SECTIONAL VIEW, DIESEL ENGINE.

During the charging stroke of the piston, air is drawn into the cylinder through the automatic valve marked "air" in Fig. 78, but no oil is drawn in. On the return stroke the piston compresses its charge of air to something like 500 pounds pressure per square inch, producing a temperature of about 1000 Fahrenheit. At the end of the compression stroke, the fuel valve is opened and the oil forced into the cylinder by compressed air, the latter being obviously required on account of the pressure existing within the cylinder at that moment.

The oil enters in the form of fine spray, and is instantly ignited by the high temperature of the air, mentioned above. The working stroke follows, of course, and then the exhaust stroke. Oil is admitted to the cylinder during about one-tenth of the working stroke of the piston, and is ignited as fast as admitted; after the supply is cut off the burning gases act expansively, of course.

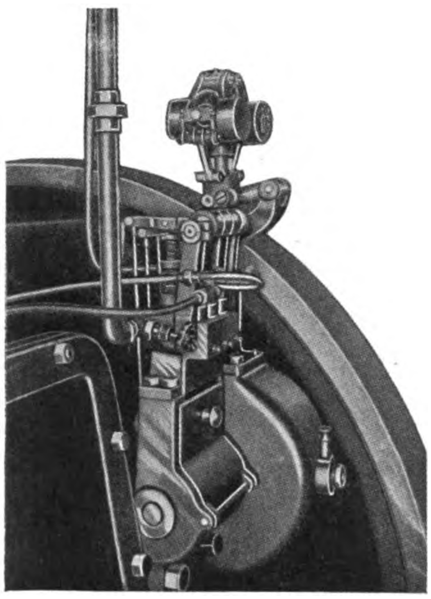

FIG. 79.—PUMP AND GOVERNOR, DIESEL ENGINE.

Speed regulation is effected by varying the quantity of oil sent to the fuel valve for injection into the cylinder. The oil for each cylinder is pumped to the fuel valve by a small oil pump, and the governor controls a by-pass around the pump; Fig. 79 shows the pumps for a three-cylinder engine, together with the governor and the three by-pass valve-rods adjusted by the governor.

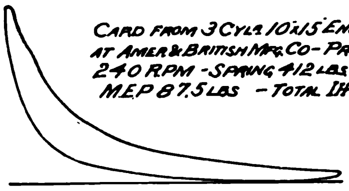

FIG. 80.—INDICATOR CARD FROM DIESEL OIL ENGINE.

In addition to the distinctive features of extremely high compression and the ignition of the fuel by the temperature due to compression alone, the Diesel engine has the unique characteristic of operating without any explosion or increase of cylinder pressure above the pressure of compression. The oil is burned as it enters the cylinder, and since it enters in very fine particles (spray) the burning does not take the nature of an explosion, but occurs gradually and continues until the combustible gases are burned, the expansion during this combustion being the impelling force. This is clearly shown by the indicator diagram reproduced in Fig. 80, which was taken from an engine developing 103 horse-power. The manufacture of the Diesel engine is controlled in this country by The American Diesel Engine Company, New York.

Igniting Generators.

The widely used method of igniting the charge of a gas engine which consists of connecting a sparking coil and a battery to the electrodes of the igniter proper is too well-known to require any discussion. In addition to this, there are several magneto generators built for use in the place of the battery and spark coil. Two of the most recent and most ingenious of these are described here. One is built by The Auto-Igniter Company, and the other by the Goodson Electric Ignition Company, both of New York. Fig. 81 shows the "Auto-igniter," which is a dynamo of the inductor type. The revolving element is a disc of soft iron, which has an oblong opening cut near the rim and carries a piece of non-magnetic metal set into this hole; this is indicated in Fig. 81 by the dark spot near the bottom edge of the disc. The permanent field magnet is provided with two polar projections of soft iron, on one of which is mounted a single coil, the only winding on the machine. The disc rotates between the faces of the two polar projections and the face of the opposite magnet pole, and the non-magnetic piece of metal set in the disc is of such shape and size as to lap the edges of both polar projections when it is in alignment with them and to conform to the outline of a pole when its edge is opposite the edge of the pole with the latter covered. It is obvious that while the iron part of the disc is between the poles the magnetic circuit is nearly closed, and the flux is maximum; when the inserted metal passes the poles, the reluctance of the magnetic circuit is suddenly increased and the flux weakened, producing an e.m.f. in the coil; when the iron part of the disc again enters the air gap, another e.m.f. is induced, so that there is a double impulse or two impulses one immediately following the other. The absence of collector rings and brushes is a particularly advantageous feature in a machine of this small size and operated under the conditions of neglect that are inevitable in this case. Fig. 82 shows one of these igniters attached to an engine; the disc is mounted directly on the engine shaft and the magnet held by braces from the bed frame.

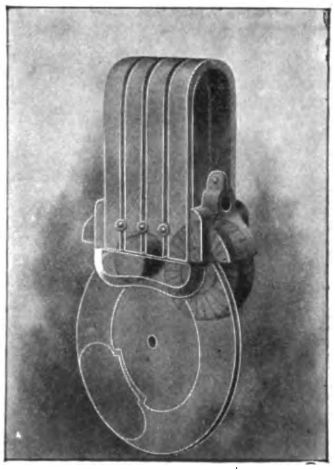

FIG. 81.—AUTO-IGNITER.

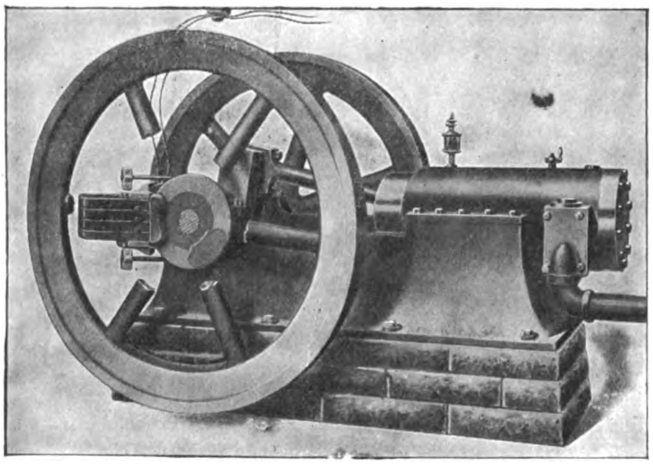

FIG. 82.—AUTO-IGNITER IN POSITION.

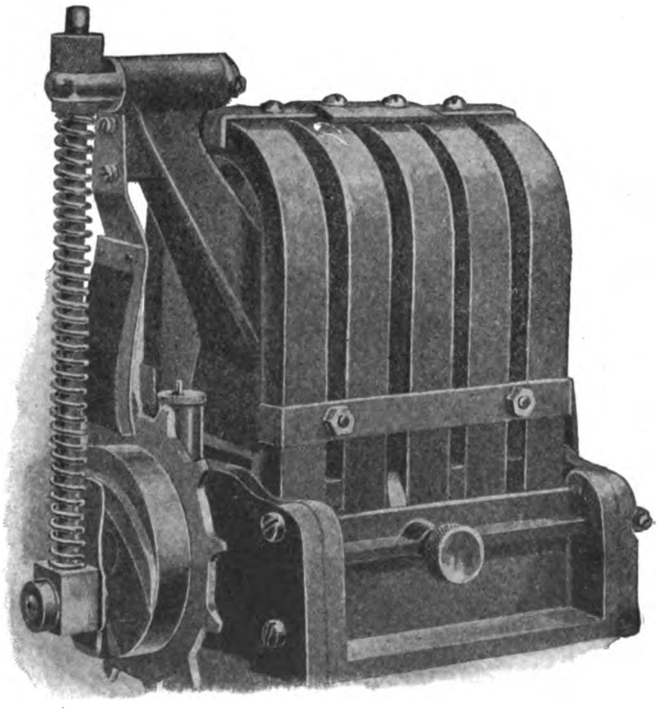

FIG. 83.—THE GOODSON GENERATOR.

The Goodson apparatus comprises a complete system of igniting generator and igniter plug and involves the probably unique feature of having the igniter electrode oscillated by an electromagnet. Fig.

83 shows the generator complete. The armature shaft is driven by the sprocket wheel shown in the engraving, a chain being used to belt this wheel to a mate on the secondary shaft (if a two-stroke-cycle engine). The sprocket is mounted loosely on the shaft, however, and rotates the latter through half a revolution by means of a lug engaging a similar lug on the crank disc outside of the sprocket. This crank disc is keyed to the shaft, and when the sprocket wheel has carried it around to a point where the crank-pin is just past the upper center, the helical spring runs the crank disc through the other half revolution with a snap, far in advance of the motion of the lug on the sprocket wheel. The igniting e.m.f. is induced by this sudden motion, and it is evident that since the spring carries the armature through the second half revolution without regard to the movement of the sprocket wheel, the e.m.f. is always the same, no matter what the speed of the sprocket wheel may be. Therefore, the ignition of the charge is as reliable when starting up as when running at full speed.

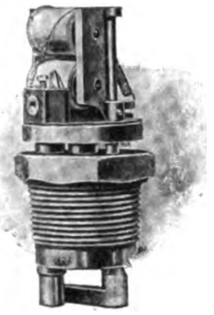
FIG. 84.—GOODSON SPARK PLUG.

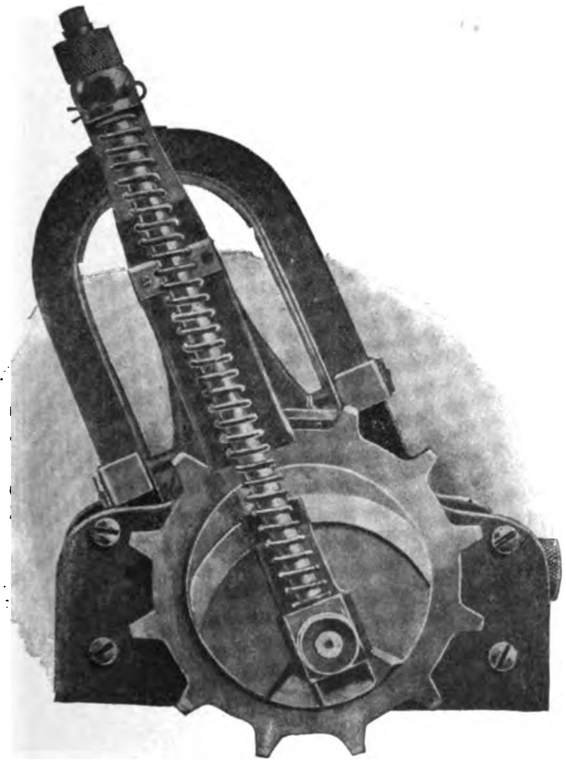
FIG. 85.—GENERATOR TILTED FOR LATE IGNITION.

The Goodson spark plug is shown by Fig. 84. It carries on its head a small electromagnet, the armature of which is mounted on the spindle of the movable electrode. When the magneto generator sends its sharp impulse of e.m.f. to the plug, the magnet is energized and separates the electrode contacts. The armature is adjusted so that it will not respond to the feeble e.m.f. produced by the generator during the first half revolution, through which it is driven by the sprocket wheel.

The field magnet of the generator is mounted on pivots co-axial with its armature shaft so that it may be tilted one way or the other, and the time of ignition thereby adjusted; Fig. 85 shows the magnet tilted in the direction to produce late ignition, the direction of shaft rotation being counter-clockwise. This view also shows the ingenious brake used to bring the shaft to rest at the end of its quick motion and avoid hammering by the lugs on the sprocket and the crank disc. The crescent-shaped surface is raised above the face of the disc, and a flat spring mounted on the head of the spring-supporting rod rubs against this crescent surface when the crank-pin is at the "rest" position, but does not touch it during the second half revolution when the armature shaft is under the control of the helical spring. This ignition system has been adopted by The Fairbanks Company for use on its gas engines, as noted in the description of that company's product.

Abstracts from Foreign Contemporaries

Gas Producer for Bituminous Coal.—Considerable attention is being paid to the problem of producing gas from bituminous coals, free from objectionable tarry vapors which give so much trouble when such gas is used in gas engines. Fig. 1, taken from the London *Mechanical Engineer,* shows how Crossley Brothers, the well-known gas engine builders, propose to attain this end. In gas producers as usually constructed the fuel is generally fed into the top of the producer, arranged with the object of keeping a reserve of fuel and a constant working fuel depth. In this apparatus the fuel is fed into a closed retort and the resultant volatile gases and vapors are then passed into the lower portion of the fuel bed of the gas producer together, along with steam and air or other gases. Any tarry vapors present in the mixed gases and vapors are broken up during their passage through the heated fuel, leaving the upper portion of the producer as permanent gases and enriching the other gases produced. The engraving shows an arrangement in which the fuel is distilled in the retorts *A* by means of the sensible heat of the gases and the radiant heat of the fuel in the producer, the caked residue being afterward fed into the producer and consumed there. The retorts are arranged with hollow spiral castings *B,* which close the bottom end. Screw tackle is arranged so that the casting *B* may be rotated independently of the screw. When charging a retort the valve face of the casting *B* is tightened in its place, and fuel admitted into the retort is projected downward into the spaces between the spirals by turning the capstan *C*. When discharging a retort the casting *B* is first lowered a distance by means of the tackle and the capstan is then turned in the same direction as when charging. The coked fuel in the retort *A* is then projected downwards and broken up by the spirals. The volatile gases given off from the green coal in the retorts *A* are conducted by way of the pipes *E* and *F* to the lower portion of the fuel bed of the producer. When a charge has been completely distilled in a retort the gas outlet therefrom is shut off temporarily by means of the dampers *G*. The coke or residue is broken up into suitable sections by the spiral *D* and is dropped out of the retort into the producer. A fresh charge is fed into the retort through the door which is then secured, and the damper *G* again opened. The fuel after passing through the retorts will not cake a second time, and is thus very suitable for use in the producer, and the gas produced is more uniform than that obtained in the usual manner.

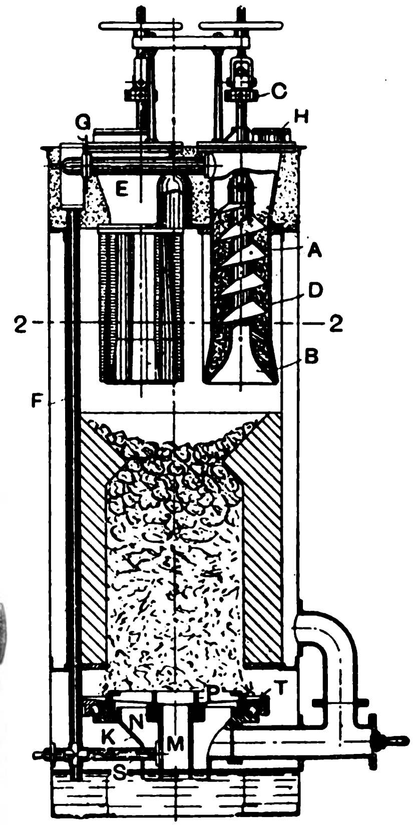

FIG. I.—CROSSLEY GAS PRODUCER.

Regenerator for Gas Producers.—The adaptation of the principle of Green's well-known economizer or feed-water heater to the regenerative heating of the air and vapor supplied by gas producers forms the subject of a patent granted to A. Wilson, a description of which appears in a recent number of the London *Mechanical Engineer.* The gas issuing at a high temperature from the producer is caused to pass among tubes through which the air, or mixture of air and vapor, to be heated passes. The sensible heat of the hot gases is thus transmitted to the mixture in the tubes, the hot gases entering and passing through a chamber at as near a point as convenient to where the gases leave the fuel. The tubes in this chamber are arranged, preferably at right angles to the direction of the current of the hot gases, and fitted if desired with a mechanical scraper or other cleaning appliances to remove any deposit of tar, soot or dust. The air or other mixture after passing through the interior of one stack of tubes and becoming heated, enters the water chamber and there encounters a water shower and absorbs a certain amount of water vapor which causes the generation of steam. The vaporized air or mixture of air and steam is then sent through a second stack of pipes before its introduction to the producer. In this way the evaporation of water is effected by the hot gases issuing from the producer in a vessel which can be readily cleaned and examined. The gases from the producer flow through the stack of regenerator tubes in a direction opposite to the direction of flow of the mixture in the interior of the tubes, which may obviously be arranged in several groups and modified to suit circumstances much in the same way as a Green's economizer.

Self-Contained Self-Regulating Gas Plant.—Fig. 2 herewith, taken from the London *Mechanical Engineer,* represents Dunlop's self-contained self-regulating gas plant, which is intended to produce from bituminous coal a gas suitable for use in a gas engine cylinder without the necessity of any attention further than that of filling the generator completely with fuel and turning on the water supply. A gas generator of this kind must of necessity contain within itself the means of regulating the quality of the gas produced, and when bituminous fuel is used it must insure against the formation of clinker, and at the same time the arrangement must be such that no tarry vapors or other combustible hydro-carbons are contained in the gas that enters the engine cylinder.

The manner in which these results are secured in the generator is illustrated as follows: The gas generator consists of a metal shell with an inner cylindrical shell lined with firebrick. At the lower end is a rocking grate with a poking finger. The shells are so arranged that free communication is established at all times between the top and bottom of the generator. Placed centrally in the generator is a water-jacketed collecting pipe, through which the gases produced are drawn off to be cooled and washed for use in the gas engine cylinder. The fuel is supplied by two hoppers at the top, and the water supply to the collecting pipe jacket is regulated by a cock, and sealed by a syphon pipe. The collecting pipe jacket is in free communication with the top of the generator, the upper end of the collecting pipe being closed by a lid, through which the condition of the fire may be observed, or through which the fire may be started by a piece of cotton waste soaked in petroleum. From the collecting pipe the gases pass to a tubular heat interchanger, shown at the side of the generator, the gases passing downwards, inside the tubes, which are in two lengths telescoping each other. The water overflowing from the collecting pipe jacket passes by a syphon seal to the top of the heat interchanger, and, flowing over the upper ends of the tubes, descends in a film inside the tubes along with the gases. At the same time a regulated quantity of steam is mixed with the gases as they leave the collecting pipe.

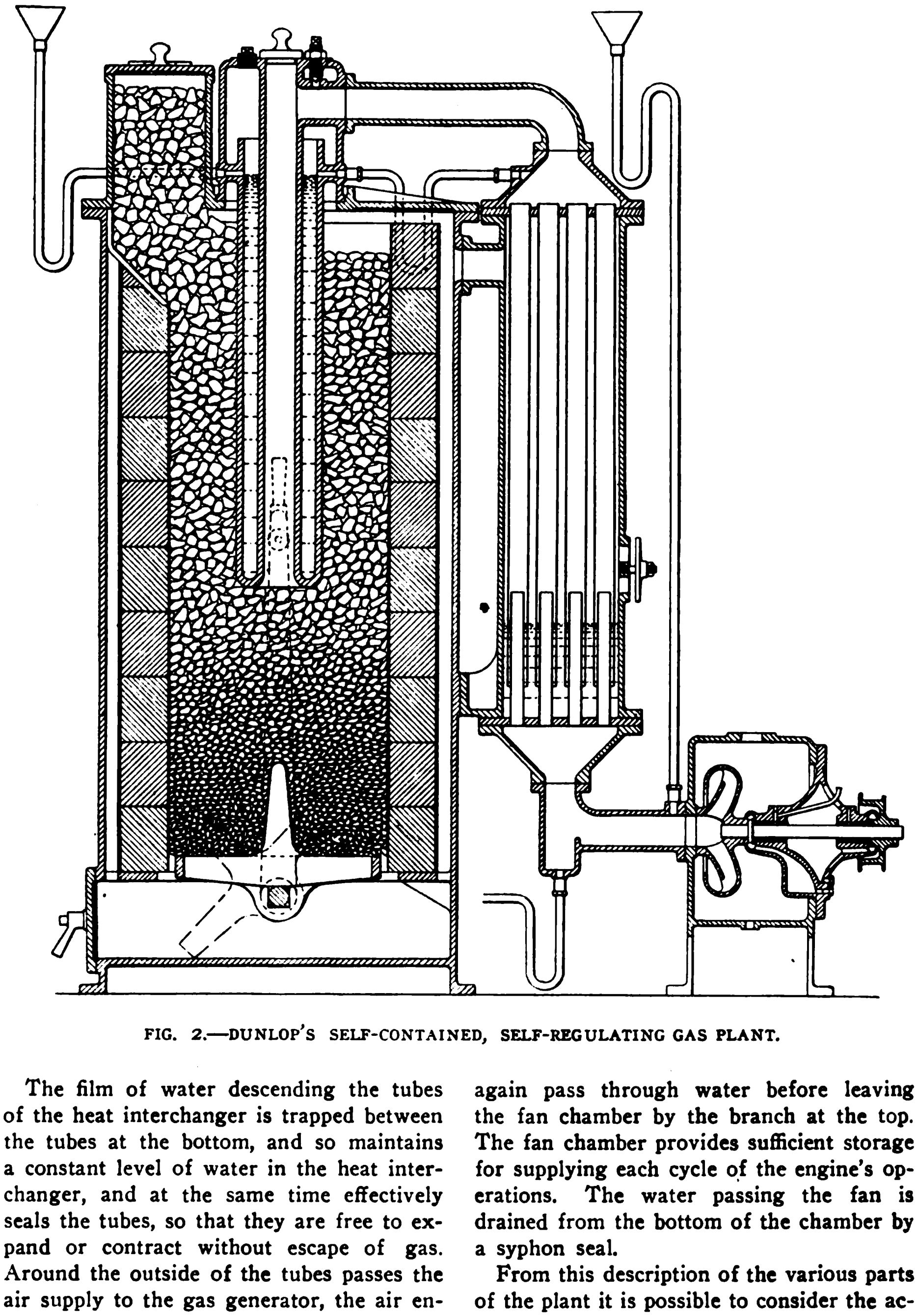

FIG. 2.—DUNLOP'S SELF-CONTAINED, SELF-REGULATING GAS PLANT.

The film of water descending the tubes of the heat interchanger is trapped between the tubes at the bottom, and so maintains a constant level of water in the heat interchanger, and at the same time effectively seals the tubes, so that they are free to expand or contract without escape of gas. Around the outside of the tubes passes the air supply to the gas generator, the air entering the adjustable opening close to the surface of the water, and passing into the lining of the generator near the top.

The surplus water from the bottom of the heat interchanger passes away through a syphon seal, and a fresh supply of cold water enters along with the gases into a centrifugal cooler and washer. This cooler and washer consists of an exhaust fan driven by the engine at a moderate speed sufficient to relieve the engine of the work of drawing the gases through the generator, etc. The construction is specially designed for the purpose of condensing the steam mixed with the gases, and for removing any tarry vapors or other condensible hydro-carbons that may have passed over with the gases. For these purposes the periphery of the fan is surrounded by a U-shaped ring, which maintains a water seal around the periphery, and through which all the gases must pass on their way to the engine. The water overflowing this seal is spread out in a sheet around the ring, so that after passing the seal the gases must again pass through water before leaving the fan chamber by the branch at the top. The fan chamber provides sufficient storage for supplying each cycle of the engine's operations. The water passing the fan is drained from the bottom of the chamber by a syphon seal.

From this description of the various parts of the plant it is possible to consider the actions that take place.

Assuming the plant in operation, air enters the heat interchanger at a rate determined by the speed of the washer fan and the requirements of the engine as adjusted for by the plate locked on the side of the heat interchanger. As it enters this air mixes with steam rising from the water in the bottom of the heat interchanger, and passing upward around the tubes is heated by the gases passing inside the tubes. When it enters the generator this mixture of air and steam mingles with a further quantity of steam overflowing from the top of the generator. This second quantity of steam is what is left of the steam generated in the jacket of the collecting pipe after supplying the amounts that pass direct downwards through the fuel, and that pass away with the gases at the top of the pipe. The mixture of air and steam passes direct to the closed ashpit, being heated up by contact with the inner shell, so that it is in a fit state to maintain a rapid rate of combustion when it passes through the grate. The amount of steam, however, is such that the formation of clinker will be prevented. In passing upward to the collecting pipe the air in this mixture first promotes combustion of the fuel, and later forms with the carbon of the incandescent fuel a mixture of carbon monoxide and nitrogen. The steam is dissociated, the hydrogen passing to the collecting pipe uncombined, while the oxygen combines with carbon to form carbon monoxide. While this action is taking place the steam in the top of the generator is driving the gases distilled from the fuel around the collecting pipe downwards through the incandescent zone, the tarry vapors and condensible hydro-carbons in these gases being there split up into fixed gases and passed to the collecting pipe.

Automatic Motor Starters.—The *Elektrotechnische Rundschau* contains a description of two automatic starters designed for either starting or stopping motors from a distance. The starters are manufactured by the German Lahmeyer Company, and are applicable for direct and alternating-current motors. Both for stopping and starting the lever of the rheostat is actuated by the motor in question, but the speed of the movement of this lever is, of course, different for turning on and switching off the current. In Fig. 3 *A* denotes the starting resistance. As soon as the motor begins to rotate, the lever *h*, by means of an intermediate crank, *k*, is set into a rocking motion. It carries two pawls, *Z*, Z_1, which are pressed by springs against the toothed disc *S*, fastened on the spindle of the starting lever. The meshing of either pawl is effected by means of a rod, *a*, and an electromagnet, *e*. So long as no current flows through the electromagnet *e*, the pawl *Z* is kept away from the toothed disc by means of a pin *s*. This is the position of the mechanism when at rest. If now the motor circuit is closed, no matter where, it is obvious, as seen from the diagram, that the electromagnet *e* is energized and attracts its armature. The pin *s* is lowered, and the upper pawl *Z* comes into contact with the toothed segment. Since the resistance on the first stop is so dimensioned that the motor receives sufficient current to start, the rocking lever *h* gradually cuts out the resistance, this lasting according to the length of the toothed periphery. Although the lever *h* continues to rock to and fro, the starting lever remains on the last stop. If the motor is to be stopped, the switch is opened, the armature of the electromagnet being thereby released. The upper pawl is drawn away from the segment *S* by the pin *s*, and the lower pawl Z_1 now comes into contact with the teeth of the disc, rapidly bringing the starting lever back to its original position. In virtue of the momentum of the motor armature, the lever *h* will continue to rock for some time, without, however, causing any further movement of the disc *S*. Another arrangement is shown in Fig. 4, the chief difference between it and the former device being the adoption of a clutch instead of a pawl and ratchet-wheel. A worm-wheel, *R*, is attached to the lever of the starting box (shown in the sketch arranged for three-phase work) and is driven by a worm, *W*, in a clockwise or counter-clockwise direction, according as which of the two wheels *S* and S_1, rotating in opposite directions, is coupled to the shaft carrying the worm *W*. Both wheels are driven by the motor, but with different speeds; the one for starting—*i.e.*, S_1—turns slowly as compared with the other one, *S*, which is employed for switching off the motor. On completing the motor circuit, the energized electromagnet *M*, in attracting its armature against the pull of a spring *F*, couples the worm *W* to S_1. The disc *R* begins to rotate, and resistances are cut out until the pin s_1, striking the lever, causes S_1 to become disengaged. On opening the circuit, the armature of *M* is released, and the tension of the spring *F* is sufficient to cause the left-hand clutch to engage, connecting thereby the worm *W* to the quickly rotating pulley *S*. The disc *R* is rotated until the pin *s* disengages the clutch.

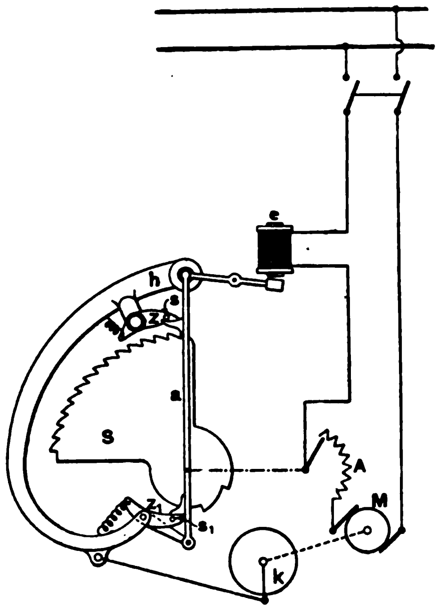

FIG. 3.—AUTOMATIC MOTOR STARTER.

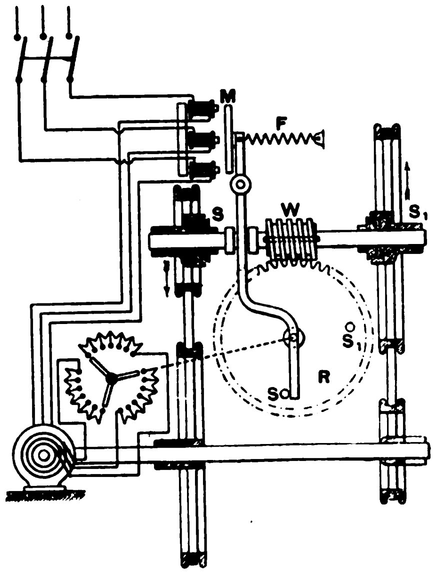

FIG. 4.—AUTOMATIC MOTOR STARTER.

A New Detector of Hertzian Waves.—W. Schloemilch describes, in a recent issue of the *Elektrotechnische Zeitschrift*, a new detector for Hertzian waves, which is based on electrolytic principles. Although still to some extent in the experimental stage, its essential points may be gathered from this description. If a cell, consisting of platinum or gold electrodes immersed in dilute acid, be connected to a source of electricity, the e.m.f. of which slightly exceeds the back e.m.f. of the electrolytic cell, a small and constant current will traverse the latter, producing at its electrodes a feeble generation of gases. On electric waves impinging upon this cell an increase of the decomposing current is observed. In order to increase the effect of the phenomenon, the surface of the positive electrode is made as small as possible, and it may be mentioned in this connection that the Gesellschaft für Drahtlose Telegraphie, the maker of the detector, employs electrodes only 0.001 mm. in diameter, and of a length of about 0.01 mm. The negative electrode, on the other hand, has seemingly no material bearing upon the phenomenon, and may consequently be used in any practical form or size. So far, the exact nature of the phenomenon remains unexplained, and it is not settled whether the cell acts as a capacity or as a resistance. The gas bubbles are more easily detached under the influence of the impinging waves, and with strong impulses this is marked to such a degree that the Morse signals sent may, it is stated, be interpreted directly by observing these fluctuations. If, however, the small electrode be changed over, so as to form the negative plate of the cell, the effect produced by the impinging waves is nearly nil, and it may be concluded, there-

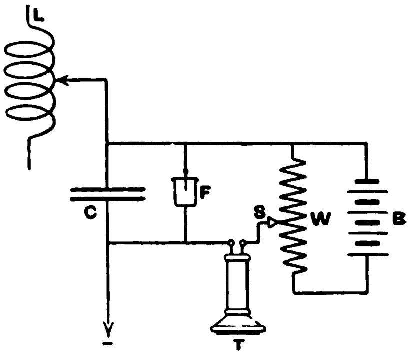

FIG. 5.—DIAGRAM OF CONNECTIONS FOR HERTZIAN WAVE DETECTOR.

fore, that the effect depends on the nature of the gas produced at the small electrode. It is necessary to adjust separately for each cell the applied e.m.f., because the sensitiveness of this wave detecting device is greatest at a certain rate of gas production, and diminishes both for a greater or smaller generation of gas bubbles. In special cases the auxiliary battery may be dispensed with by making the cell itself a primary battery, which can be done by choosing electrodes of suitable metals. In this form, however, the sensitiveness is less than in the former case. One of the diagrams of connection, which may be followed with good results, is shown in the illustration. In this engraving *L* represents the air wire; *E*, earth; *T*, telephone; *W*, resistance; *C*, capacity; *F*, electrolytic detector; *S*, moving contact, and *B*, a battery.

Steam Trap for High Pressures.—In the London *Engineer* is described the steam trap illustrated by Fig. 6 herewith and devised by Holden & Brook, who claim that it embodies in the one apparatus all the advantages which experience in trap work has suggested. For instance, it is stated that while the action of the trap is perfectly quiet its discharge, which is distinct and intermittent, has been greatly increased in quantity, making the trap free from dribble, and that owing to the peculiar construction of the valve it, together with its seat, is protected against cutting. Regarding the action of the trap, a straight piece of brass tube *A* when filled with condensed water contracts. The yoke piece *J* is then pressed against the ends of the rods *R* and *R'* by the action of the studs *J'*, which are fixed to *C*, the latter being screwed to and forming one piece of the tube *A*. As a result of this, both *R* and *R'* are forced against the upper and lower portions of the mechanism, shown at the left-hand of the engraving. *R'* comes against a rigid portion which will not give; the consequence is that since the rod is hard up against *J*, as is also the rod *R*, the expansion of *R'* is practically added to the expansion of *R*, making the left-hand end of the latter travel just twice as far to the left as it would have done had it been alone. The movement is sufficient to depress the lever *D* and to open the valve *E*, thus allowing the water to escape. It is stated that owing to its special construction and to the steam pressure being against it the valve does not open gradually in accordance with the motion of the lever, but hangs back and opens wide and suddenly, so that any foreign particles are readily blown out, and as it closes in the same manner the discharge is quite positive and the objectionable dribbling avoided. Another feature claimed is that the traps contain no delicate parts which cannot be repaired or replaced by an ordinary mechanic. When steam re-enters the tube *A*, after the expulsion of the water, the tube re-expands and by releasing the pressure on the rods *R* and *R'* permits the lever *D* to rise and the valve *E* to reseat itself. To blow through by hand the extension to the lever, *T*, is depressed. This lever returns to the closed position on release by the action of the spring *D'*. The cap *L* can be removed without interfering with anything else and the valve and seat examined or withdrawn. *M* is an adjusting screw provided with a locknut for regulating the discharge.

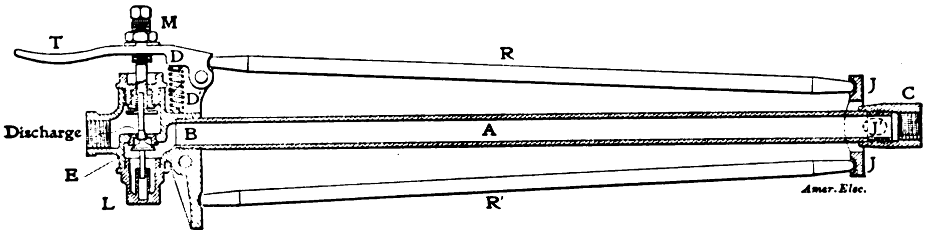

FIG. 6.—HOLDEN & BROOK STEAM TRAP FOR HIGH PRESSURES.

Vaporizers for Oil Engines.—In internal combustion engines of the compression type, and more particularly those in which the fuel consists of hydro-carbon oils, in which a heated explosion chamber or vaporizer is in open communication with the working cylinder through a contracted passage, part of the air from the cylinder is forced by the engine piston during the compression stroke through the contracted passage into the vaporizer, where after mixing with the vaporized hydro-carbons and forming an explosive mixture it is ignited, and the piston is driven out on the power or working stroke of the engine. The ignition may be due partly to the heat of the vaporizer and partly to the heat imparted by compression, or it may be due to external or other causes. Engines of this type usually require to work with a great percentage of explosions on possible working strokes at all loads, from no load to heavy load, in order to retain the vaporizer at the requisite heat, and the gear which operates the fuel inlet is usually arranged in such a manner that at no load or on a light load only a small quantity of oil enters the vaporizer for the working strokes, and on a heavy load a greater quantity of oil for the working strokes.

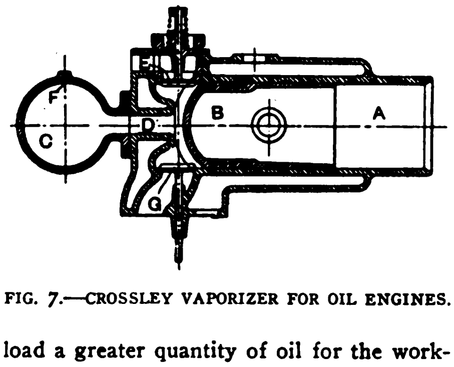

FIG. 7.—CROSSLEY VAPORIZER FOR OIL ENGINES.

The accompanying sketch, for which we are indebted to the London *Mechanical Engineer*, illustrates an invention of Crossley Brothers, which consists of means whereby this form of vaporizer may be retained at a sufficient temperature even without it being necessary to alter the quantity of fuel for the working strokes at different loads. These means consist of providing the engine with a governor which prevents the exhaust valve being opened when the speed of the engine exceeds the normal, and therefore prevents the burnt charge escaping, and also prevents the admission of new charges of either oil to the vaporizer or air to the cylinder. The burnt charge, being retained in this way, is compressed and expanded from time to time, until the speed of the engine is reduced to the normal, when the action of the governor permits this burnt charge to escape and allows the admission of a new charge of oil to the vaporizer and air to the cylinder, the two being afterwards compressed, mixed, and ignited as before. During the governing period, when the burnt charge is being compressed and expanded in the cylinder and vaporizer, it remains at a comparatively high temperature, and serves to prevent such rapid cooling of the vaporizer as might otherwise take place. Fig. 7 illustrates the cylinder of an engine provided with a vaporizer of the type described. In this figure the cylinder, which is water jacketed, is shown at *A*, the piston at *B*, the vaporizer at *C*, the contracted passage between the cylinder and vaporizer at *D*, the air-admission valve at *E* the hydro-carbon inlet at *F*, and the exhaust valve at *G*. The governor is not shown.

Regulating Fuel Supply to Oil Engines.—The arrangement shown in the accompanying engraving has been designed for the purpose of utilizing the suction of the main piston of an oil engine for introducing the liquid hydro-carbon into the vaporizer, thus obviating the necessity for using any special means for the purpose.

Fig. 8 is an end elevation of the cylinder and vaporizer of an internal-combustion engine provided with the arrangement, the latter being partly in section, and a vertical section drawn to a larger scale of the regulator suction box, is shown to the left. *A*

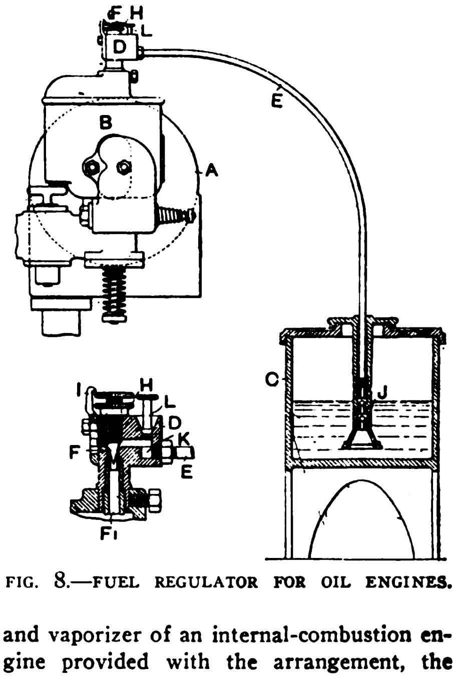

FIG. 8.—FUEL REGULATOR FOR OIL ENGINES.

is the cylinder of the engine and *B* the vaporizer. *C* is the tank containing the supply of hydro-carbon, and *D* the regulator suction box connected with the vaporizer *B*, *E* being the pipe connecting the tank and box together. *F* is the needle valve in the box *D*, by which the quantity of oil to be drawn into the vaporizer through the passage *F*, by the suction of the engine piston can be regulated by adjusting the position of the point of the valve relatively with its seating. *H* is a nut for locking the valve *F* when adjusted. *I* is a pointer arranged in connection with the head of the stem of the valve *F*, the head being provided with a graduated upper surface. *J* is a double ball valve at the end of the suction pipe *E* within the tank *C* for insuring that the pipe *E* shall always be full of oil; and *K* is a recess in the box *D*, which is located below the level of the mouth of the passage F_1, controlled by the valve *F*, so that the oil from the upper part of the pipe *E* shall not drain past the valve *F* into the vaporizer, the recess *K* forming a small reservoir into which the pipe *E* opens. *L* is a screw plug in the box *D*, which plug, when the screw *G* is upon its seat, is removed, so that the pipe *E* can be filled up with oil before starting the engine. By the arrangement described it will be seen that during the out stroke of the piston of the engine oil will be drawn thereby from the tank *C* through the pipe *E* past the valve *F* into the vaporizer *B*, the valve *F* being regulated according to the quantity of oil required for each explosive charge. We are indebted to the *Mechanical Engineer* of London for the foregoing data.

Notes on the German High-Speed Railway Trials.—The *Elektrotechnischer Anzeiger* publishes an interesting article on the recent high-speed railway trials between Marienfelde and Zossen. As is known, these trials have been carried out by the "Studiengesellschaft für Elektrische Schnellbahnen." Preliminary trials and laboratory tests with regard to air pressures at high velocities showed that a parabolic form offered the least resistance, this being about 90 kg. per square metre at a speed of 200 km. per hour. To reduce this item further, Siemens & Halske gave the top of the car a tapered form, so as to appear like a hood. Very little alteration appears to have been made in general design of either of the cars since two years ago. The Siemens & Halske car affords seating capacity for 48 passengers, and is 22 metres (72 feet) long and 2.56 metres (8 feet 4 inches) wide. On the other hand, the car of the Allgemeine Elektricitäts Gesellschaft has a length of 21 metres (69 feet) and a width of 2.8 metres (9 feet 2 inches), and provides room for 40 passengers. Both are built as corridor cars. The bogies are mounted on springs, both spiral and flat springs being used. At the beginning of the tests a wheel base of 1.9 metres (6 feet 3 inches) was employed, the wheels being 1.2 metres (4 feet) in diameter; afterwards these dimensions were increased. Brakes—operated on the Westinghouse system and also by hand—act on every wheel, and an electric brake, actuated by current from a storage battery, is also provided. It is stated that if the brakes are applied when the car is traveling at 200 km. (124 miles) an hour, it travels a distance of 1.5 km. (nearly a mile) before stopping. The cables were placed underneath the floor and on the roof of the car. In the Siemens & Halske car all control operations are done by pneumatic means, the driver having, consequently, only light work to do. Mechanical means were employed by the Allgemeine Elektricitäts Gesellschaft for transmitting these operations to the various apparatus distributed at different parts of the car. For this purpose a main shaft runs along the ceiling of the car. Owing to the construction of the bogies, and also to the high speed of the cars, gearing between the motors and axles was neither possible nor desirable, and the 250-h.p. motors—two for each bogie—are mounted directly on the axle, and in the case of the Siemens & Halske car without the intervention of springs. The Siemens & Halske motor weighs 4 tons, and its rotor is fed with three-phase current at a potential of from 1150 to 1850 volts, the voltage of the stator varying between 500 and 1000. Arrangements are provided to connect the transformer at will, either in star or delta fashion. The Allgemeine Elektricitäts Gesellschaft motor is lighter, weighing only 3.2 tons. Its conductors consist of copper bars, the voltage of the rotor and stator being 325 and 435 volts, respectively. A play of 30 mm. (1.18 inches) between the hollow axle of the motor and the car axle has been allowed by this firm, and a mechanical connection between the two is provided by means of a spring coupling. Siemens & Halske adopted metallic resistances —built up of metal strips—which were well cooled by being placed on the outside the car. Liquid resistances with forced circulation were employed by the Allgemeine Elektricitäts Gesellschaft. They possess the great advantage of gradually increasing and decreasing the working current. The transformers are mounted horizontally beneath the floor and efficient cooling by air presents no difficulties. In the Allgemeine Elektricitäts Gesellschaft's car, the air for cooling was collected from the roof and conducted through pipes to the transformers. A vertical iron pipe is mounted in the car and through it all the cables are conveyed from the roof to underneath the floor. Instead of mounting the three collector bows on one vertical hollow steel post as Siemens & Halske do the Allgemeine Elektricitäts Gesellschaft employs for each bow a separate pole. Of the total weight of about 93 tons, 16.3 tons are in motors, 12.3 tons in transformers and 5.1 tons in resistances. In the course of the trials, however, it became evident that the total weight might be reduced by several tons. Siemens & Halske constructed the overhead equipment. At a distance of 7.4 feet from the center of the track is the line of wooden posts. These are spaced 38 yards apart and carry horizontal iron brackets to which the overhead wires are attached by means of double insulators. A small horizontal play is thus secured to the wires, and this is said to ensure a good contact between bow and wire. A distance of 39 inches separates the wires, which are vertically mounted one above the other. Every kilometre (0.62 mile) the overhead wires are anchored to resist horizontal stresses. At these points section switches are inserted in the line. If a high-tension wire should break, the line conductors are automatically short-circuited. This is performed by a loop of copper wire, which normally encircles a metal rod connected through the track rails to the common point of the three-phase system. When any one wire breaks, the loop is drawn together and comes into contact with the rod. As feeders, both cable (with a copper section of 70 square mm.) and bare copper conductors (section 50 square mm.) were employed. Suitable switches are interposed between the feeders and the line wires. Electric energy is generated at the power station situated at Oberspree by a 2500-h.p. three-phase alternator, delivering current at 6000 volts. Two transformers, connected in parallel, raise the pressure to 14,000 volts. After many preliminary tests and calculations, the actual speed trials were commenced on the line Marienfelde-Zossen, 23 km. (14 miles) in length in 1901. Since the maximum gradients are but 1 : 200, and the smallest curves have a radius of not less than 2000 meters (6550 feet), this line is particularly suited for high-speed tests. The results of these trials and other particulars have been reported from time to time in our columns.

Steam Engine, Turbine, and Gas Engine Compared.—W. A. Chamen, in the course of his inaugural address as chairman of the Glasgow Local Section of the Institution of Electrical Engineers, referred to the increased employment of steam turbines. So successful, he said, had the larger sizes of steam turbine proved that there was a likelihood of his adopting this type of plant before long for the Corporation of Glasgow in connection with its general electricity supply. Referring to gas engines, he said that the capital cost of a gas engine, dynamo, and producer plant at the present time seemed to be considerably more than the cost of steam engines, dynamos and boilers, and was far greater than that of steam turbo-generators and boilers. This was no doubt partly owing to the comparatively low speed of gas engines, and to the fact that in large sizes it did not seem possible to construct vertical engines. The turbine operated by gas pressure was, he thought, little more than a dream. The difficulty appeared to be that the necessary cooling was so expensive as to rob the machine of any efficiency which might otherwise be expected. Saving of fuel was useless if it tended to increase the standing charges. Referring to the question of superheating, he said this had not been successful hitherto, owing probably to the difficulties of keeping the amount of superheat of the steam within the necessary limits and of finding a lubricant for the internal parts of the engine capable of standing high temperature.

SOME RECENT ELECTRICAL PATENTS

Insulator.—The progress of high-tension power transmission and the tendency toward higher and higher potentials for such lines has resulted in many notable improvements in insulator construction. One of the latest forms of insulators for this class of service is that shown by Fig. 1 herewith and devised by Fred M. Locke. This insulator is of the now well-known sectional or multiple-petticoat type, but it differs from the others of that class in the provision of air spaces between the successive sections of the insulator, these sections resting on each other merely at the edges, as shown at *f* and *g* in the drawing. The sections are fused together at the points of contact. Patent No. 745,284.

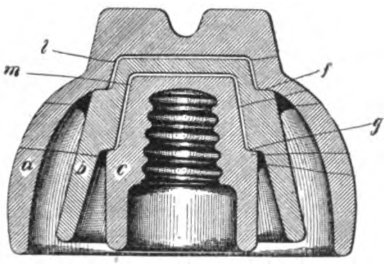

FIG. 1.—HIGH-TENSION INSULATOR.

Induction Motor.—Figs. 2 and 3 herewith illustrate the rotor of an induction motor which has been patented by Donald M. Bliss. The object of the invention is to reduce the starting current required by the motor and the inventor accomplishes this by providing two independent systems of inductors on the rotor, one of these, *b*, having relatively high resistance and the other, *c*, relatively low resistance. The high-resistance inductors are permanently close-circuited, and at starting up these are the effective ones, the low-resistance system being open circuited. As the speed increases, the balls, *h*, are thrown outward by centrifugal force, and their action against the beveled face of the collar, presses that inward against the opposition of the helical spring, f_3, and close-circuits the low-resistance inductors by means of flexible contacts carried by the collar. With the low-resistance system of inductors thus connected up, the presence of the high resistance set has practically no influence upon the operation of the machine. Patent No. 745,772.

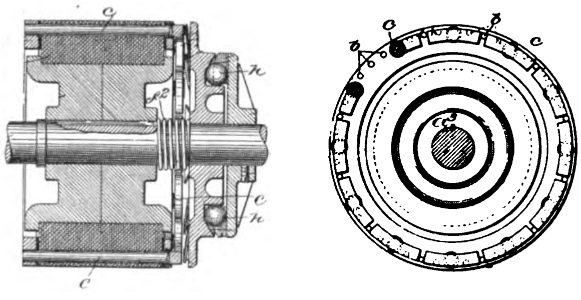

FIG. 2.—INDUCTION MOTOR.—FIG. 3.

NOTES.

Index of the Technical Press—One of the most convenient of the several European publications having for their object the recording of the titles, authors' names and general character of articles appearing in the technical press is the *Index of the Technical Press*, published monthly at Brussels, Belgium, which is just starting on the second year of its existence. Unlike most of the publications of this class, the *Index* restricts its references to the technical articles to a mere statement as to the character of the article, and does not give anything like an abstract or a digest of it, hence its name. The list of periodicals covered by the *Index* is of rather appalling length, and gives a very fair idea of the magnitude of the undertaking.

The Electric Club Journal.—The Electric Club, of Pittsburg, an organization of young engineers connected with the Westinghouse interests, has decided to issue an illustrated monthly magazine which will be known as *The Electric Club Journal.* The first number will appear next month. The chief object in issuing the journal will be to put in a permanent form the engineering papers and technical discussions which form part of the regular work of the club, and many of which are written by members of the engineering staff of the Westinghouse Company. The page of the new magazine will be 6 ins. by 9 ins., and there will be probably 48 pages in each issue. Mr. Frank D. Newbury is the editor and Mr. John H. Smith, business manager.

American Society of Mechanical Engineers.—The annual meeting of this society was held in New York December 1 to 5, inclusive. The address of the president, Mr. James M. Dodge, on the subject of "The Money Value of Technical Training," is worthy of preservation and frequent perusal by all beginners or intending beginners in any branch of technical work. Among the several extremely interesting papers read at the various sessions was one by Mr. C. H. Morgan, of Worcester, Mass., in which the author described very meagerly a proposed gas engine of the walking-beam type to operate on the two-stroke cycle. The description would probably have been of much value if it had been more lucidly presented and not mixed up with remarks concerning a totally different type of gas engine. Mr. Frank B. Perry, Boston, Mass., read a paper on the method of determining rates and prices for electric power, in which he criticised the step rate system, one of the points of criticism being the inconsistency of the method which makes it possible for a consumer's bill to be less for a meter read just beyond the point where the rate changes than it is for a meter reading just below that point. Mr. Perry's argument, however, was not very practical, and the value of his deductions was considerably impaired by his apparent unfamiliarity with the ruling rates for electric power. Other papers were read as follows: "Tests of a Compound Engine Using Superheated Steam," by D. S. Jacobus; "The Pressure Temperature Curve of Sulphur Dioxide Vapor," by Edward F. Miller; "Construction and Efficiency of a Fleming Four-Valve Engine Direct Connected to a 400-kw. Generator," by Benjamin T. Allen; "Slide Rules for the Machine Shop," by C. G. Barth; "What are the New Machine Tools to Be?" by Professor John E. Sweet; "Improvements in the Valve Motion of Duplex Air Compressors," by Sterling H. Bunnell.

Test of the First Turbine for the Interborough Power House.—An interesting series of tests was begun at the Westinghouse Machine Company's works, on December 21, of the first 1250-kw. turbine-generator set for the Interborough Rapid Transit power house. The first two tests, which were completed on December 21, consisted of running under full load with 27 inches vacuum and under the same load with 28 inches vacuum. The generator is a three-phase machine, operating at 11,000 volts, and was loaded by means of a three-compartment water rheostat supplied through transformers at 500 volts potential in order to avoid the difficulties of handling the generated pressure. All measuring instruments were in duplicate and readings were taken every five minutes during the test. The full-load tests were made with 66 amperes in each phase, and after making the usual corrections the results of the first two tests mentioned showed a steam consumption of 20.1 pounds per kilowatt-hour (15 pounds per electrical horse-power-hour) with 27 inches of vacuum, and 19.4 pounds per kilowatt-hour (14½ pounds per electrical horse-power-hour) with 28-inch vacuum. At the finish of the two economy tests, the efficacy of the governor and automatic safety stop was demonstrated. The load was thrown on and off instantaneously several times and the change of speed was barely perceptible. The governor lever was held down so as to leave the turbine uncontrolled and allow it to run away; the safety stop had previously been set for 10 per cent excess over normal speed, and when the turbine attained this the safety stop operated and shut off the supply of steam instantly.

The series of tests is in progress as we go to press, and we regret that time limitations make it impossible to obtain the results from the complete series for publication in this number.

Developments in Gas Motors and Power Gas Generators.—After describing the arrangement and working of suction gas plants, H. Neumann, in a paper recently read before the Association of German Engineers, discussed the problem of cost. For a 60-h.p. plant, the operation by lighting gas, producer gas and electromotors, respectively, were compared both for full and half loads. For outputs as high as 150, 300 and 1000 horse-power steam engines were next compared with producer gas plants, also for half and full loads. It was pointed out that producer gas plants are by no means limited to anthracite, operation by coke being in many cases more advantageous. Cheap anthracite dross may also be employed, though the generator should be made of special form where this fuel is used, and the steam-air mixture introduced under pressure. In an experimental plant of 60 horse-power installed in the workshops of the Gasmotorenfabrik Deutz, 3.6 cubic meters of gas of 1300 heat units per cubic meter were produced from a kilogram of moist anthracite dross (the maximum size of grains being 8 mm. and the percentage of water 10 per cent). As a modern gas motor uses 2000 heat units per horse-power-hour, the consumption of coal will be 0.45 kilograms per horse-power-hour. (Our correspondent evidently refers to metric horse-power and kilogram-calories.) As brown coal plays a specially important part in Rhenania and Saxony, the above firm exhibited a generator gas plant for brown coal at the Duesseldorf exhibition, where with brown coal having a heating value of 2400 heat units, the generator produced from one kilogram of carbon 1.5 cubic meters of gas having a value of 1200 heat units, the consumption of carbon per horse-power-hour thus being 1.12 kilograms. These satisfactory results are due not only to the progress made in the field of generator construction, but as well to the improvements made in gas engines. By a convenient modification of the combustion chamber the builders are able to increase the compression without the danger of premature ignition.

Interstate Independent Telephone Association.—The third general meeting of this association was held at Chicago on December 8, 9 and 10. About 500 delegates and visitors were present, and there was a very good showing of exhibits. Among the papers that were read was an extremely interesting one by Professor J. C. Kelsey, of Purdue University, on the subject of "The Standardization of Telephone Apparatus," and another by W. C. Polk, of Kansas City, on "The Standardization of Telephone Construction." Professor Kelsey in his paper urged that a committee be appointed by the Interstate Association for the purpose of making tests with a view of standardizing apparatus and material for all the independent companies, the committee to be composed of representative telephone engineers. Mr. Polk in his paper suggested a national organization board composed of experienced practical engineers and construction superintendents, this board to furnish advice for investors and operating owners. Mr. H. D. Critchfield, one of the Independent pioneers and now representing the Illinois Telephone Company which put in the Chicago automatic exchange, gave an interesting talk on the subject of the Illinois Telephone Company's progress and plans. The automatic apparatus used by this company is that formerly known as the Strowger ssytem. Mr. Critchfield stated that 21 miles of tunnel had been completed in the Loop district for telephone cables, freight purposes and other public utilities, and that the company proposed ultimately to complete 92 miles of tunnel. He stated that toll line connections would be ready for service into Chicago next fall. The officers for the ensuing year were as follows: H. A. Barnhart, of Rochester, Ind., president; E. H. Moulton, of Minneapolis, Minn., vice-president; E. M. Coleman, Louisville, Ky., secretary; A. B. Conklin, of Aurora, Ill., treasurer. The new executive board consists of O. Rex, North Manchester, Ind.; C. E. Hull, Salem, Ill.; J. S. Bellamy, Knoxville, Iowa; Richard Valentine, Janesville, Wis; W. G. Jones, Columbus, Ohio; H. G. Conger, Hannibal, Mo.; W. Matthews, Maysville, Ky.; C. E. Wells, Kansas; J. G. Splane, Pittsburg, Pa. The association adjourned without day.

A New Rapid Type-Printing Telegraph.—A novel kind of rapid type-printing telegraph is being developed, and has just been brought out in Germany by the Siemens & Halske Company. The apparatus belongs to the class of the so-called automatic telegraphs (Pollak-Virag system) in which the telegram is prepared by a typewriting device piercing for each letter to be telegraphed a given hole or set of holes in a continuous paper ribbon. The latter on being drawn through the rotating telegraphic transmitter will automatically send corresponding current impulses into the circuit. In the Siemens apparatus, two holes are pierced in the paper ribbon for each letter, the letter being also printed in plain type form immediately above, so that the perforated ribbon contains the telegram in distinct readable form. In order to insure the accurate printing of 2000 letters per minute without any delicate mechanical apparatus, the electric spark is employed. A disc in which the various letters are cut out as in a pattern is rotated at a speed of 2000 turns per minute through a spark-gap and a continuous ribbon of photographic paper. Whenever a spark passes in the gap, a silhouette of the letter at that instant in front of the latter is projected on the paper ribbon. It is evident that the spark must be produced with an accuracy as high as one 40,000th part of a second in order to have the proper letter appear at the proper place. The paper ribbon next passes beneath some sponges impregnated with developing and fixing liquids, the photographic process requiring only 9 seconds, and the ribbon is delivered printed. The problem of causing the spark to be produced with accuracy at an instant in accord with the current impulse transmitted from the sending apparatus was solved by utilizing to a high extent the property of electric condensers of being susceptible of charging and discharging in very short intervals. The receiver, apart from the photographic device, comprises a shaft driven by an electric motor on which, in addition to the above-mentioned type disc, some brushes are mounted sliding over contact discs, together with five relays of special design, the tongues of which follow the rapid impulses of the transmitted current. A special and rather ingenious device causes the receiving apparatus to perform in a given time precisely the same number of revolutions as the transmitter.

The Berlin Teletyping Exchange.—A novel exchange, of the class of the ordinary telephone exchange, was recently opened at Berlin. The instruments are printing telegraph machines of a peculiar form, known as "teletypers." The keyboard of the teletyper is similar to that of an ordinary shift-key typewriter, comprising superposed rows of seven keys each. Of these, 26 are transmitting keys, one serves as beginning or letter key, and the other, bearing the inscription "Zahl," is the shift key, the type-wheel having two rows of characters on it. The apparatus may be used either as a sender or as receiver without any special preparation or switching being necessary, both instruments being automatically and simultaneously operated by the keys of either of them. As soon as the "beginning" key of either machine is pressed downwards the circuit of the transmitting apparatus is completed, resulting in a switching roller being set rotating, sending alternating electric currents into the printing circuit and through the line relays connected to the apparatus; the latter control, both in the transmitting and receiving apparatus, local currents which by means of magnets produce the rotation of the type-wheels from the position of rest. When a letter key is pressed downwards, a peg on the other end of its lever strikes against the rotating switching roller brush, stopping the latter and thereby the type-wheels of the machines. At the same time the type levers of both machines are attracted, causing the letter corresponding to the depressed key to be printed. As long as the key is pressed downwards, the type-wheels are held in the position to which they were rotated, so that transmission can be effected at any desired speed. After a telegram is transmitted, both the transmitter and receiver are switched out automatically at a certain position of the type-wheel, stopping the apparatus. Twelve cells of storage battery serve as working battery. The line e.m.f. is about 12 volts, which is obviously so low as to exclude any possibility of an inductive influence by the printing telegraph circuits on neighboring telephone circuits. The central station or exchange just opened is fitted with a switchboard having indicators, etc., for 100 subscribers. As soon as a subscriber presses down the calling key of his teletyper, the switchboard operator is advised by the indicator of the subscriber in question dropping and an alarm being rung, when he will put himself in communication with the caller, ask for the desired connection, and connect both subscribers, almost exactly as in telephone exchange operation.

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The American Electrician has a larger paid circulation list than any other electrical journal in the world.

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The New Year.

To all of our readers we extend once more our wishes for a happy and prosperous year. Unfortunate developments in some industrial lines have had a retarding influence upon almost every branch of industry during the past year, but we believe firmly in the "never say die" disposition which incites men to smile in the face of misfortune and refrain from croaking. If we are not very much mistaken, most of the electrical fraternity are of that optimistic class and will join us in toasting the New Year and expecting from it the full measure of prosperity.

◆

The Internal Combustion Engine.

The article relating to American gas and oil engines which appears in this number, while it does not include every engine built in this country, is an excellent presentation of the status of gas engine design; there are many builders of gas and oil engines ranging from 5 to 100 horse-power, only two are actually building gas engines of 500 horse-power, and there are just two oil engines of high power designed with regard to electric service. It is a significant fact, however, that several American manufacturing establishments have acquired rights to build gas engines of foreign design, and while this does not appear to be especially complimentary to the engineering talent of this country it at least indicates a commendably enterprising spirit. Referring again to the gas engine article, even the most casual reader will doubtless note that of the engines described, only three work on the two-stroke cycle, and one of these is a toy so far as real engineering is concerned; another is built in the respectable sizes of 100 to 200-h.p. units, while the third compares favorably with large Corliss engines in magnitude of output. The reason for this is very clear. The production of a two-stroke-cycle gas engine capable of a performance equal to that obtainable with the four-stroke cycle is an engineering problem involving prodigious difficulties. Some highly capable specialists have decided that the two-stroke cycle is a sort of sirenical impracticability; others, that an economical two-stroke-cycle engine is merely a matter of high-grade engineering but that the game is not worth the candle commercially. On the other hand, there are engineers of international repute, such as Borsig and the Körtings, who have adopted the two-stroke cycle and are building very large engines of this class.

* * *

A complete self-contained engine working on the seductive two-stroke cycle is evidently impractical in large sizes. Hence it is that the Körting and Oechelhauser machines are accompanied by external pumps for controlling the air and gas. This, however, does not involve a great amount of complication, especially as the pumps are practically parts of the general construction. In both engines a liberal charge of air is sent into the cylinder to clear out the burned gases just before the explosive charge is admitted. We confess inability to conceive that these operations with elastic media can be so exactly controlled as to prevent one or two of three objectionable results, *viz.*: loss of some of the fresh charge through the exhaust ports, retention of a considerable quantity of burned gases, and uneconomical mixture of the incoming explosive charge with the scavenging air left in the cylinder. Since the engines in question are actually doing commercial work of importance, however, it is fair to assume that the disadvantages mentioned have been reduced to commercially negligible proportions. If it were practicable to compress the explosive mixture to 150 lbs. or thereabouts in a separate reservoir and deliver it to the engine cylinder ready for ignition, the two-stroke-cycle engine would at once be placed on the same plane with the steam engine as to the available number of impulses per revolution. Also "if" a reliable and uncomplicated method of doing this is ever devised, the four-stroke cycle will take its place in the same class with the simple D-valve for steam engines and the open-arc lamp.

* * *

In the matter of gas-engine speed regulation, no conspicuous advances appear to have been made during the past five years. The rather uneconomical method of regulation by throttling the explosive mixture is practically the only resort of the gas-engine designer when steady angular motion is essential, as in driving dynamos. The case is different with oil engines, since it seems to make no difference in the completeness of combustion how much air there is so long as there is the minimum proportion of oxygen required by the oil. Moreover, the character of the fuel renders it very easy to vary accurately the quantity admitted and to deliver it against high cylinder pressures. Gas, on the other hand, is not so easily managed, and requires for complete combustion a definite proportion of air; above and below the correct proportion the efficiency of combustion falls off rapidly. The proper proportion of air to gas is widely different, of course, for different gas analyses. Speed regulation by varying the quantity of gas admitted, while working with constant compression, is therefore economical within a very limited range only. Throttling the complete explosive mixture is more economical, and but for the fundamental fact that the efficiency of a gas engine diminishes with a decrease in compression, it would be the ideal means of speed control. Variable expansion on a parallel with that obtained in a steam engine cylinder is not feasible with the prevailing type of gas engine, since there is no sustained pressure in a gas engine cylinder corresponding to the admission line on a steam engine diagram; it is all compression and expansion lengthwise of the diagram.

What Occurs in Telephone Wires.

We are in receipt from a regular reader of a clipping and the very direct query "Is this intended seriously?" The clipping is from the *New York Times* and contains an editorial discussion of "Telephone Phenomena," which we had already read with much interest. Among other things the *Times* writer says "The little disc in the transmitter undoubtedly vibrates. Why the corresponding disc in the receiver should repeat these vibrations if the mass of metal connecting them is inert, those who think that vibrations are not set up in the conductor may be left to explain." The *Times* had previously stated that the human voice caused the 565 tons of telephone wire between Boston and Omaha to "vibrate in unison throughout its several parts," and the present discourse is in reply to a correspondent who contradicted the original statement. We are unable to answer positively our correspondent's inquiry as to the intended seriousness of the *Times'* statements, but inasmuch as journals of its standing do not indulge in hoaxing in their editorial columns, and furthermore since the editorial which last appeared enters into a labored quibble about molecular vibrations to sustain the original assertion as to the Omaha line, it is only reasonable to ascribe sincerity to the writer or writers of both. The effort of the *Times* writer to wriggle out of the uncomfortable position created by the first statement is somewhat amusing but more pathetic. His reference to "those who think that vibrations are not set up in the wire" is an excellent specimen of hedging; it is an easy step from the vibration of a mass of metal as a whole to "vibrations set up within" it, and another short transition thence to molecular disturbances.

It is not necessary to assure any first-year student that a telephone wire is not vibrated in the slightest degree by the voice currents which traverse it. That the *Times* writer knows this quite as well as anyone else is shown by his struggle to identify molecular disturbances with vibrations of the wire as a unit in order to bolster up his original statement. This latter is evidently of the class of quasi-scientific utterances to which many sciolistic speakers and writers resort when they wish to be a little sensational. The reference to the "mass of metal which connects" the transmitter and receiver discs is inaccurate; no such condition exists in an ordinary commercial telephone circuit. But that is not material, since the writer evidently knows that the vibrations of a transmitter are not literally transmitted through the line conductor to the receiver disc; it is only one of the many slovenly expressions employed by the average daily newspaper writer in discussing technical subjects. What actually happens within the mass of a telephone or other electric transmission wire no one knows positively, not even the scientific *Times* man. But assuming the molecular theory to be correct, his contention that the phraseology of the assertion concerning the Omaha line is as accurate as the limitations of language will permit is obviously a desperate excuse, and the claim that that assertion is equivalent to a statement of what occurs according to the molecular theory, or is justified by that theory, is irrational, not to say absurd.

Unnecessary Complications.

A well-known physicist once expressed the opinion that no result should be accomplished by electrical means if it could be brought about any other way. This evidently is an extreme view if taken literally, and it was probably intended to be considered more as an admonition against the unnecessary use of electricity than to discourage one from using it at all. It is, of course, true of electricity, as it is of every other means to an end, that it should not be employed for any purpose if the desired results can be obtained more economically otherwise; when costs are even, however, results should be accomplished by the most direct method always. In this connection "costs" include expenditure of personal vigor and mental effort, and drafts upon similar assets other than money and time. One of the prime requisites to success in engineering is directness—directness of thought, directness of personal effort, directness of mechanical means. Roundabout methods are always wasteful and frequently disastrous in all classes of work except politics—but perhaps politics should not be classified as work.

It is not infrequent that one finds an elaborate aggregation of apparatus used where a much simpler arrangement would produce at least as good and possibly better results. Engine valve-gears and electric motor controllers are fruitful subjects of such elaboration. Among the chief features that caused the instant success of a well-known engine governor are its simplicity and directness of action. Many of the gas engines described in this issue embody those same characteristics. On the other hand, one finds other pieces of apparatus refined and elaborated to such a degree that the interest on the cost of the "improvements" is two or three times as great as any possible gain in economy, even if the apparatus were operated twenty-four hours a day continuously and were not more liable to failure than a simpler design. Quite as frequently, too, complex methods or whole systems are advocated or employed where much simpler and more reliable media serve as well or better. For example, wireless telegraph apparatus has been proposed recently for automatic fire alarm service. If there ever was a case where "any other method" is preferable this surely is one. If anyone should sit up nights for a month ferreting out a list of applications for which wireless telegraphy is wholly unfit this would lead the list. Many actual instances could be cited of the application of means unsuited to the end in electrical engineering and allied branches. The burden of these remarks, however, is not to hold up to criticism anyone's practice, but to urge directness and consistency in engineering methods and designs.

The Hurry Craze.

Mankind was ever inconsistent. We see hordes of unhappy people jammed on the platforms of express trains on the elevated roads, most of whom could just as well ride on a slower "local" train arriving some six, eight or perhaps ten minutes later. Mr. Jones stands in the lobby of an office building talking with a friend for fifteen or twenty minutes, and growls with rage when the elevator gate shuts just too late for him to get that car and forces him to wait thirty or forty seconds for another; or works himself into an ill temper over the snail's pace of the elevator system which takes two minutes to take him up to the top of the building. It is the same way in every phase of city life involving power transit; men grasp frantically at any device to save a few minutes or seconds of time, and demand all sorts of speed characteristics in local transit systems which, when analyzed, do not amount to the value of a dozen handkerchiefs a year to any one person who utilizes his time sanely. Where is it all to stop?

DESIGN FOR A GASOLINE MOTOR.

BY J. C. BROCKSMITH, M. E.

The engine shown in the accompanying drawings is of the high-speed enclosed crank-case type which has become quite conventional in automobile work, but which can also be used for stationary purposes and on account of its high speed is suitable for direct connection to an electric generator for battery charging or lighting.

Provided very close and accurate work has been done in fitting up the parts and under the most favorable conditions of mixture, spark, etc., this motor should develop 5 horse-power at 1000 r.p.m. Its normal speed for continuous operation, however, is 900 r.p.m., and it is suitable for driving a light automobile weighing complete not more than 500 pounds. The motor alone will weigh approximately 125 pounds completed.

Fig. 1 is a sectional view of the complete motor which shows all the working parts in their proper relation. It is obvious, of course, that the machine operates on the Otto or four-cycle plan, having a mechanically operated exhaust valve and automatic inlet valve. The cylinder is water jacketed and the cylinder, head, valve chamber and jacket are all cast in one piece, which obviates the use of packed joints. The cranks are of the disc type, and act as the flywheels of the engine. They are not as heavy as would ordinarily be adopted on a stationary engine having the cylinder dimensions of the engine shown, but in view of lightness and high speed some departures along this line are permissible.

Ignition is by means of the jump spark, the spark plug being screwed into the valve chamber directly below the inlet valve, where it will always be surrounded by fresh mixture during the ignition period. The primary contact maker is located on the extended shaft of the secondary gear, and makes a momentary contact with the spark coil once in every two revolutions of the crank shaft. The period at which the ignition takes place may be adjusted by rotating the ignitor plate through a certain angle around the cam.

The lubrication of the piston, crank and wrist pins, and main bearings is accomplished by the "splash" system. The crank case, being oil tight, is partially filled with oil or a mixture of oil and water which is distributed over the working parts by the rotation of the crank discs. This method of lubrication is open to some objections, but it is about the only simple method which can be applied on a small enclosed motor that must operate for considerable periods without attention.

Fig. 1 also shows the location of the various connections for water, gas and exhaust. Screwed connections are shown, but flanged connections could be substituted without any radical changes in the design.

Fig. 2 is a front elevation of the complete motor which shows the overall dimensions, and is useful in laying down the design of any outfit which includes the motor as part of the driving mechanism. The crank case is provided with two removable plugs, one at the bottom for draining off the waste oil, and one at the top for renewing the supply. There are two ways of keeping a supply of clean oil in the crank case, one being to use a sight feed lubricator which maintains a small but constant supply, and another way is to put into the crank case at intervals a measure of oil which must be determined by experiment and which will last for about two hours running. Fig. 2 also makes clearer the location and operation of the ignition or trembler plate.

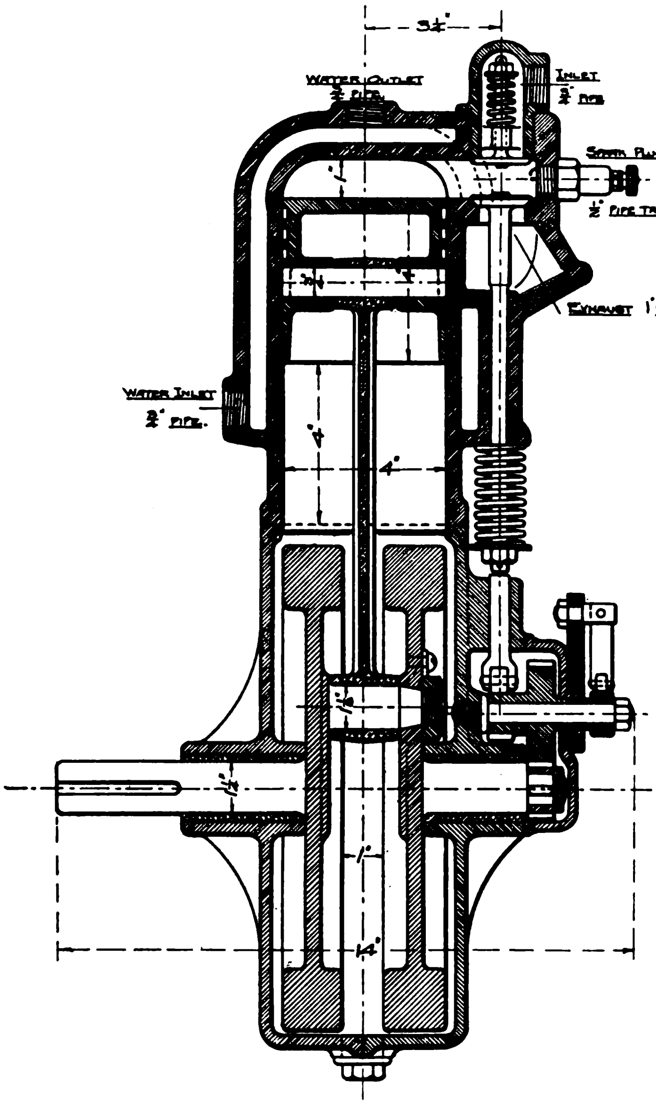

FIG. 1.—SECTION OF COMPLETE MOTOR.

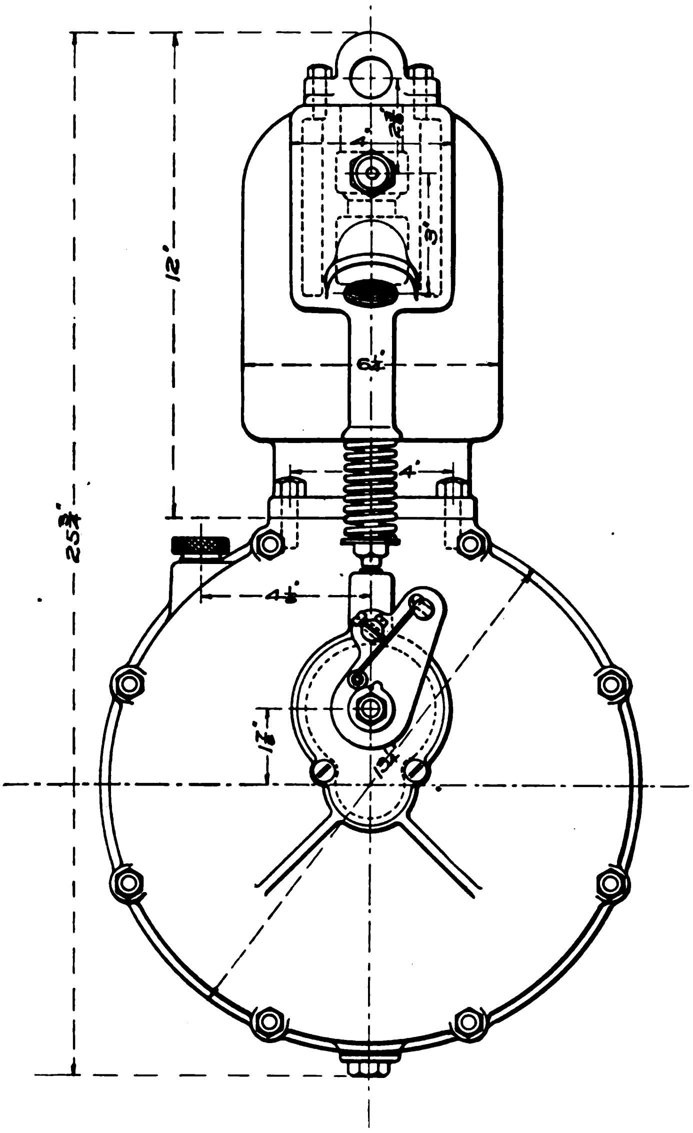

FIG. 2.—ELEVATION OF MOTOR.

Fig. 3 is a plan view of the engine and brings out the shape of the extension on the cylinder casting in which the valves are located. It also shows the lugs extending across the crank case through which are passed ⅜ in. by 5¾ in. studs with a nut at each end to draw the two halves of the crank case together. Some general dimensions are given on this view not shown in other views.

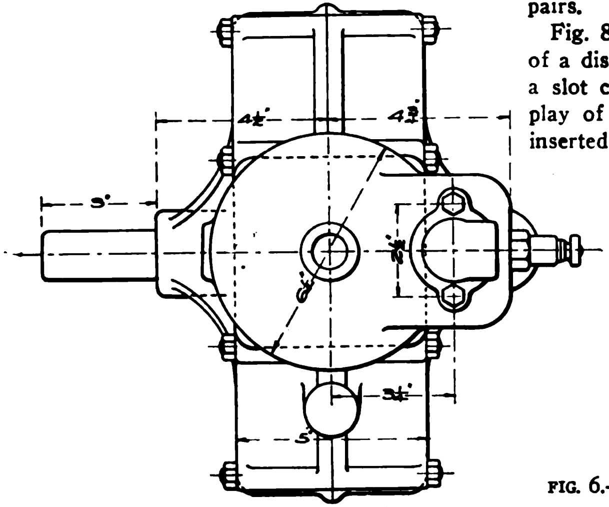

FIG. 3.—PLAN VIEW OF MOTOR.

Fig. 4 is a vertical section through cylinder, water jacket and valve chamber, and shows all the important dimensions of these parts. The cylinder should be cast in good close-grained gray iron; the bore is 4 ins., and should be finished as smooth as possible and of uniform diameter throughout.

The valve chamber should be bored 1½ ins. where the inlet valve casing enters it, and the seat of the exhaust valve should be finished to an angle of 45 degs., and the hole for the valve stem drilled exactly concentric with this facing. The end of the cylinder should be faced and a tongue turned to fit the counter-bore in the crank case.

Fig. 5 is an elevation of the cylinder with the valve chamber in section and shows some dimensions of the latter not given in other views.

Fig. 6 is a horizontal section of the cylinder taken through the center line of the spark plug opening. This view brings out the shape of the water space, which does not completely encircle the valve chamber, but is stopped off to allow openings to be tapped for the reception of the spark plug and exhaust pipe.

Fig. 7 is a section of the cylinder taken below the water jacket and shows the flange and the layout of holes thereon for bolting the cylinder to the crank case. For this purpose four ½-in. by 1¼-in. hexagon cap screws may be used, or four ½-in. studs may be screwed permanently into the crank case and the cylinder held on by means of ½-in. hexagon nuts threaded on these studs.

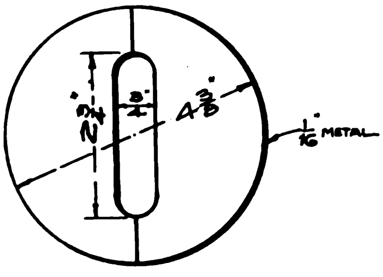

FIG. 8.—SPLASH PLATE.

This latter is the better method to use if it is thought likely that the cylinder will be frequently removed for inspection or repairs.

Fig. 8 is the splash plate which consists of a disc of sheet brass 1-16 in. thick, with a slot cut out in the center to allow free play of the connecting rod. This plate is inserted in the counter-bore of the crank case and acts as a diaphragm between the cylinder and crank case to prevent an excessive amount of oil from being thrown into the cylinder, which would foul the spark plug and thus prevent proper ignition. The size of the slot may be varied somewhat until the proper amount of lubrication is obtained.

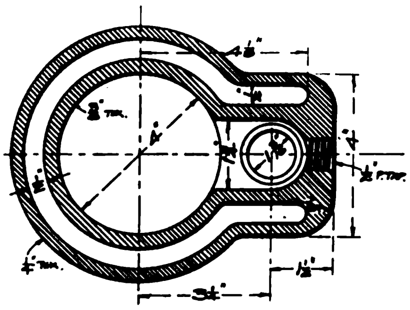

FIG. 6.—SECTION OF CYLINDER THROUGH VALVE CHAMBER.

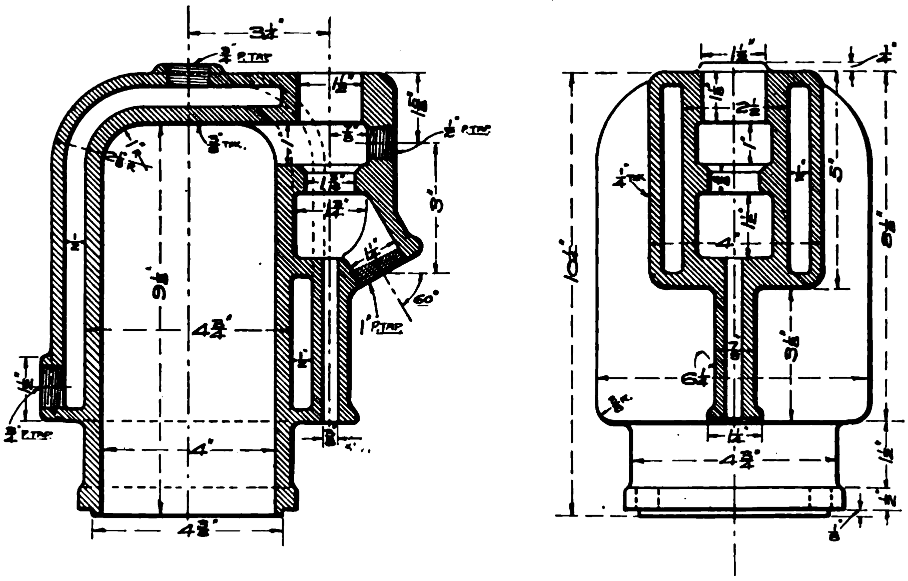

FIG. 4.—SECTION AND ELEVATION OF CYLINDER.—FIG. 5.

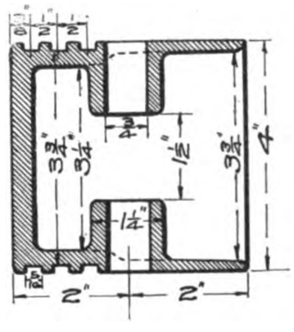

FIG. 9.—DETAIL OF PISTON.

Fig. 9 is a detail of the piston; this also is of cast iron and is provided with three grooves, ½ in. between centers, for receiving packing rings of cast iron 5-16 in. wide. These rings should be turned up about 1-64 in. larger than the bore of the cylinder, and about ⅛ in. thick. They are then cut through with a diagonal saw cut, taking out about 1-32 in., and are fitted to the bore of the cylinder so that the ends stand the merest trifle apart. When they warm up during running they will expand somewhat and become tight.

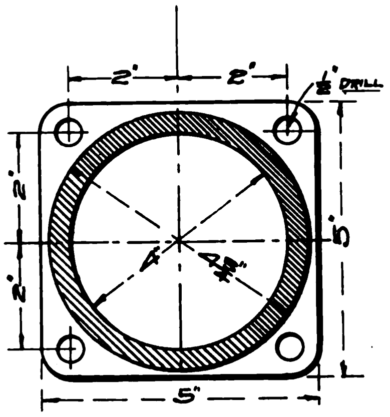

FIG. 7.—SECTION OF CYLINDER BELOW WATER-JACKET.

The body of the piston itself should be turned an exact running fit for the bore of the cylinder. The grooves should be carefully turned to a nice fit for the rings, and the rings can then be snapped into place. A ¾-in. hole must be bored for the wrist pin.

The fitting of the piston and its rings to the cylinder forms the most delicate part of the work on a gasoline motor and upon the accuracy of this work the efficiency and developed power depend to a large extent. The motor will, of course, run hard when

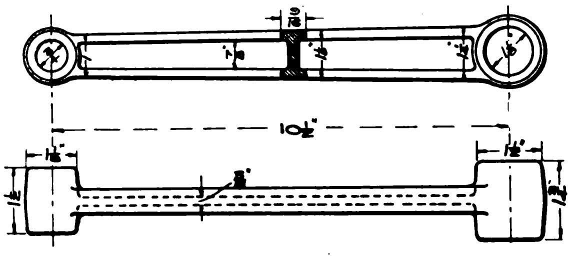

FIG. 10.—CONNECTING ROD.

first assembled, and should be driven by outside power at a moderate speed for a couple of days with a liberal supply of oil to limber up the bearings and piston.

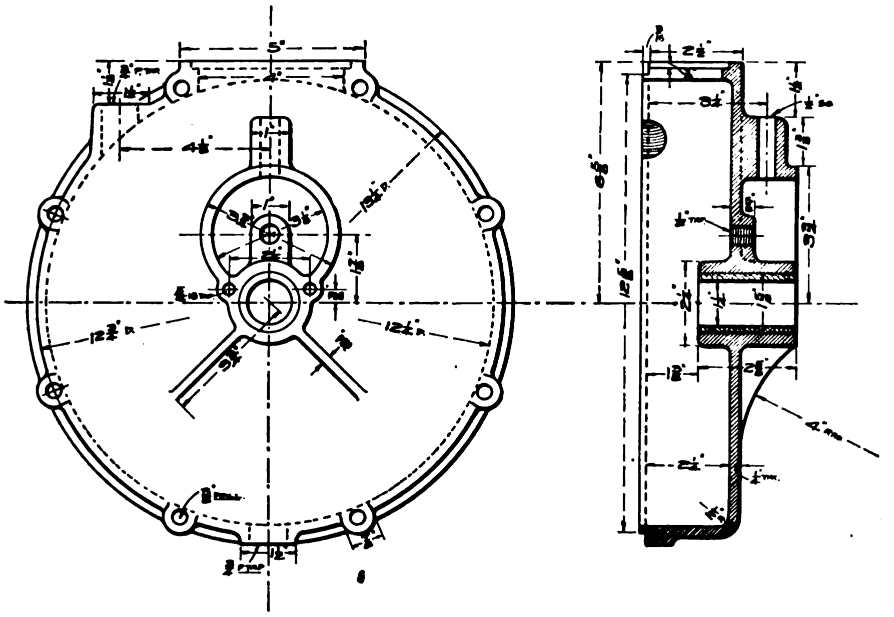

FIG. 11.—CRANK CASE.

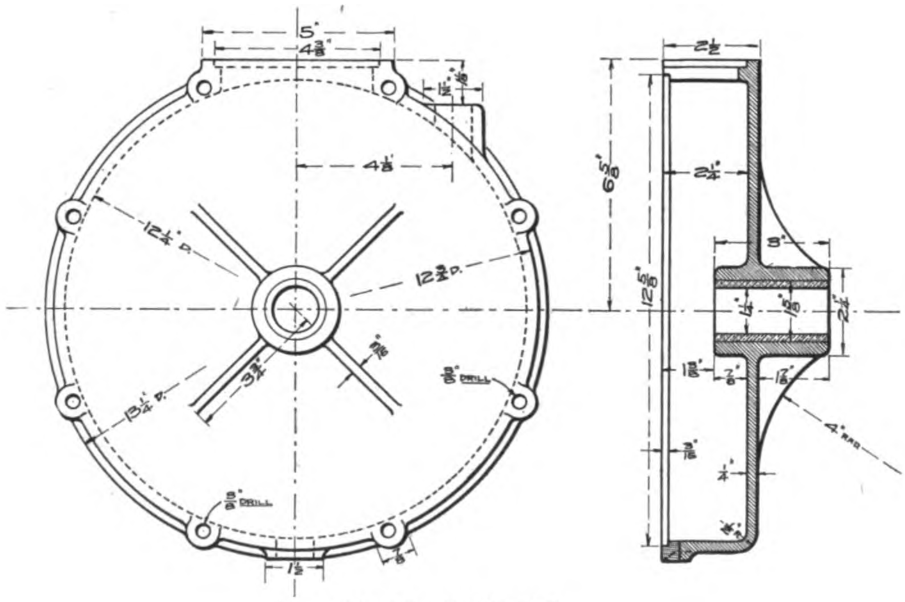

FIG. 12.—CRANK CASE.

Fig. 10 is a detail of the connecting rod which is intended to be made of a phosphor bronze casting. The only work necessary on this is the boring of the ends of the rod.

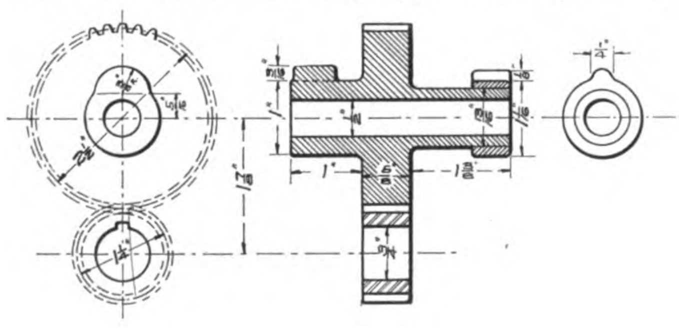

FIG. 15.—VALVE GEARS AND CAMS.

Fig. 11 shows a front view of the crank case on the valve gear side of the engine, and also a section of the same. This case is intended to be cast from aluminum-zinc alloy, containing 25 per cent to 30 per cent of zinc. Eight lugs, equally spaced around the outer periphery, are drilled for ⅜-in. studs to bolt the two halves of the crank case together. The bosses for the crank shaft bearings are provided with phosphor bronze bushing 3-16 in. thick and ribs are used to stiffen the case. The exhaust valve cam and gear are enclosed in a small box, cast integral with the crank case; the upper portion of this box serves as a guide for the exhaust valve opener; the hole is ½ in. square.

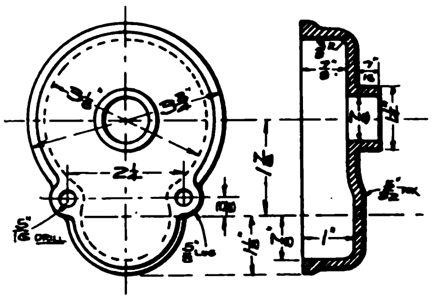

FIG. 13.—GEAR CASE.

Fig. 12 shows the other half of the crank case. This is similar to the one just described, and is cast of the same material. It does not, of course, have the gear case. One pattern can be made to answer for both halves, as they are so nearly alike that by making a couple of small changes, castings which are mates can be obtained. After bolting the two halves together they must be faced and counter-bored at the top to take the cylinder and the holes for the oil plugs must be drilled and tapped. It will be noted that where the halves come together they are matched with tongue and groove; this joint should be turned a good fit, as otherwise the oil will leak out.

Fig. 13 shows the small gear case cover which is fastened to the crank case by means of two 5-16-in. by 1¾-in. machine screws. This is cast of the same material as the crank cases, and it serves to encase the two to one reducing gears for the valve motion. It is intended that this be packed with some heavy grease to minimize noise and wear of the gears and cam.

Fig. 14 gives the dimensions of the crank discs. A departure has been made in the construction of these discs, in that there is only one screwed joint inside the crank case instead of four, as is the usual practice, with a consequent reduction in liability of the parts working loose and causing trouble. The crank discs would best be made of cast steel, but if for any reason this cannot be obtained cast iron could be used. It is not necessary to turn the discs all over; this involves a considerable amount of work, and only those parts which are to be a working fit actually need to be turned.

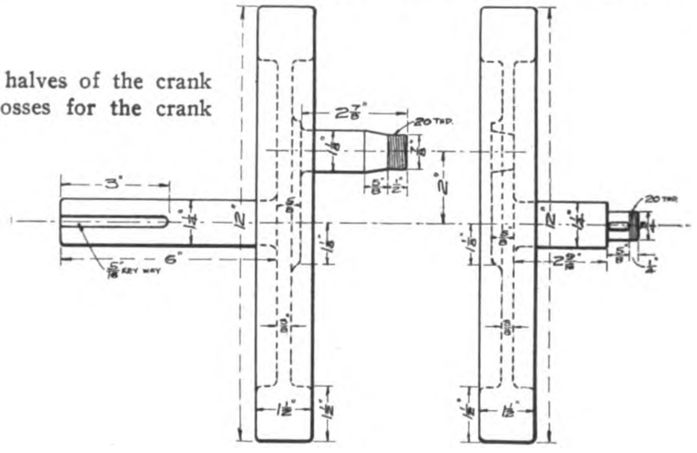

FIG. 14.—CRANK DISKS.

The cranks are not counter-balanced, but balance weights can be added if desired and screwed to the web of the discs. The exact size of these wights can best be determined by experiment. It should not be expected by the builder that the engine can be made to run entirely without vibration, no matter what arrangement of balance weight is used. There will always be a considerable amount of vibration in a light motor of this type due to the unbalanced explosion pressures in the cylinder, which cannot be eliminated.

Fig. 15 gives the dimensions of the gears for operating the exhaust valve; these are 12 pitch, with ⅝-in. face, and have 15 and 30 teeth, respectively. The large gear can be made of cast iron, but the small gear is to be of machine steel. The exhaust cam may be cast in one piece with the gear, or it can be made of tool steel and hardened. The ignitor cam is, of course, made separate, so it can be set in its proper relation to the exhaust cam. The engine can be set to run in either direction, according to the relative position of these cams.

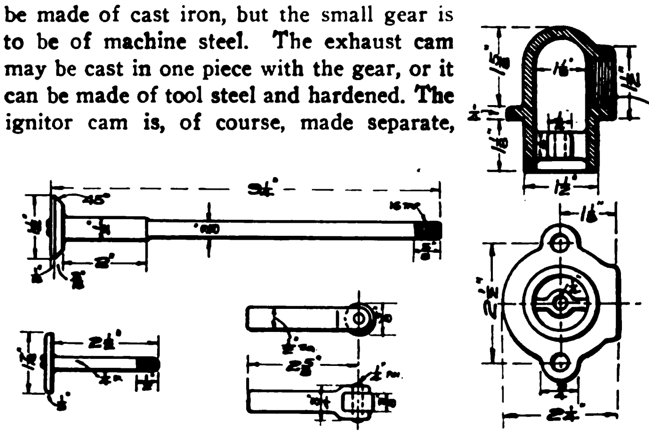
FIG. 16.—DETAILS OF VALVE CASING AND VALVES.

Figs. 16 and 17 show the details of the inlet and exhaust valves, the exhaust valve lifter, and the inlet valve casing. The valves should be turned from steel drop forgings, and should then be fitted and ground into their seats. The exhaust is finished to a 45-deg. angle, while the inlet valve has a flat seat, which makes it less likely to stick. The exhaust valve lifter consists of a square shank having a steel roller inserted in one end.

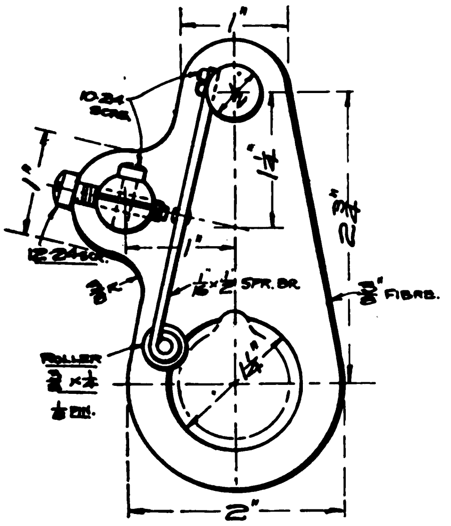

FIG. 17.—CONTACT MAKER.

The inlet valve casing is of cast iron, and is to be finished 1½ in. in diameter, where it fits into the cylinder casing; also the end is faced off to form the seat of the inlet valve. The exhaust valve spring should be quite stiff and strong, a No. 10 Bessemer steel wire coil, 1¼ inches outside diameter, will be about right. The inlet valve spring, on the other hand, should be quite light, and the motion of the valve must be limited, by means of a sleeve slipped over the valve stem, to about ⅛ inch. The lift of the exhaust valve is about 3-16 inch.

Fig. 18 is a detail of the trembler or contact makers, the function of which is to send an impulse of current through the primary of the spark coil, at the time when the spark is required to pass in the cylinder. It consists of a cam working a roller and spring blade, upon which a platinum contact is riveted. The stationary contact consists of a screw having a bit of platinum riveted or brazed into the end. A good deal depends upon the proper adjustment of these contacts.

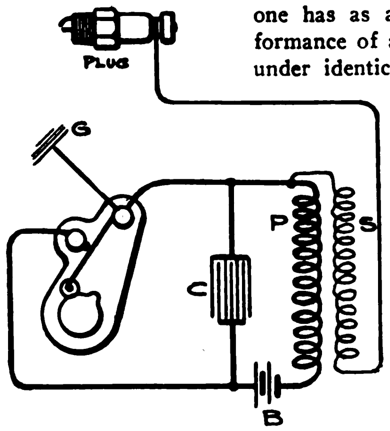

FIG. 18.—DIAGRAM OF CONNECTIONS.

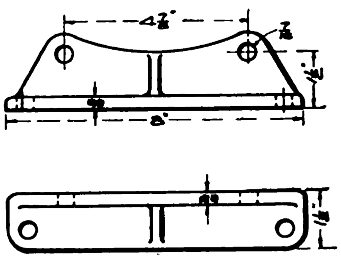

FIG. 19.—BASE.

Fig. 19 is a diagram of connections for the contact maker, battery, spark coil and plug. It will save the builder time and trouble to buy standard apparatus in plug and induction coil for use on his engine. The wiring is quite simple, as one wire is grounded on the frame of the engine, and only two other wires are necessary, one connecting to the spark plug and the other connected to the stationary contact on the trembler. It should be remembered that in this system one other ground will make a short circuit, and consequently particular attention should be given to the matter of insulation. The voltage of the sparking current is very high, and will pierce most ordinary forms of insulation.

Fig. 20 is a detail of the base castings which may be used to support the engine when it is used in stationary work. In this case the two bottom studs of the crank case are made enough longer to pass through the base castings in addition to the crank case. They would also better be made somewhat larger: about 7-16 in. in this case.

To operate the engine on gasoline a carburettor is, of course, required, and here again the amateur will do well to purchase a standard article, as a good carburettor is quite a delicate and complicated piece of apparatus, and the correct proportions of the parts have only been arrived at by long and costly experimenting.

THE CALCULATION OF MAGNET WINDINGS

BY CECIL P. POOLE.

All text-books abound with formulas for the calculation of magnet windings to give a predetermined exciting force, so that there is no lack of information concerning the fundamental principles of this work. When it is considered that in practice the resistance of a given coil may vary as much as 20 per cent. due to temperature difference, and that it is utterly impossible to predetermine what the temperature of a coil will be under operating conditions, unless one has as a guide a record of the performance of a similar coil, or one operated under identical conditions of heat dissipation, it will be evident that the fundamental formulas can serve merely as instructive guides and not as definite means for working out the desired winding.

Just ten years ago the present writer deduced and published the formula

$$d^2 = \frac{K\,At\,L_m}{V}$$

in which

d^2 = Circular mils of the wire to be used.

K = A constant depending upon the temperature of the coil and quality of the wire.

At = The ampere-turns to be obtained.

L_m = The mean length per turn of wire, in inches.

V = The volts at the terminals of the coil.

But for the fact that K may vary between 0.85 and 1.1, according to the temperature of the winding and the quality (specific conductivity at a given temperature) of the wire, the most exact results could be obtained by the use of this formula.

With the best commercial grade of magnet wire, and at a temperature of 135° to 140° Fahrenheit, the constant K becomes unity and may therefore be dropped from the formula. Table I herewith has been calculated on this basis, and will be found of immense convenience when the conditions are as stated. When they are not, the table is worthless. Since the conditions mentioned are entirely practical, the writer has made it a practice to insure that the finished winding of a magnet shall conform to them, in order that the advantages of the table may be realized in all cases. The method of accomplishing this confers inherently the further advantage of enabling one to predetermine with absolute accuracy just what exciting force will be required in the winding of the magnet in order to obtain the desired performance.

This method consists broadly of winding temporary test coils for the magnet of wire much heavier than can possibly be required for the permanent winding, and passing the proper currents through the test winding to obtain the desired magnetic and heating results. The winding is, of course, supplied from some source of current having a considerably higher e.m.f. than is necessary to excite the magnet normally with this winding, and either a water rheostat or submerged rheostat is used to graduate the current. The test coils should be wound to the dimensions that the permanent coils are intended to have, so that the radiating conditions, mean length per turn, etc., will be practically the same in both the test and permanent coils.

Before consideration of the winding is reached, the magnetic circuit to be excited must, of course, have been correctly proportioned, and it is assumed herein that this has been done, with the possible exception of the length of that part of the magnet core that is to be enclosed by the coil; this will depend on the length of coil necessary to provide the proper amount of radiating surface. It may develop, therefore, that after a magnet has been built, it will be necessary to rebuild it in order to get sufficient core length within the coil. This can usually be avoided, however, by making the core length of the first magnet a little longer than comparison with some similar magnet would suggest.

TABLE I.—Relation between Wire Size, Mean Length per Turn, and Ampere-Turns per Volt of Applied E.M.F.

Note:—The figures in lines *A, B* and *C* at the heads of the columns are Wire Numbers, in B. & S. Gauge. Those in the columns *a, b* and *c* are Ampere-Turns per Volt (At ÷ V); the numbers in column *a* correspond to the wire sizes in line *A;* those in column *b* correspond to the wire sizes in line *B*, and those in column *c* to the wires in line *C*.

a	*b*	*c*	*A* 4 *B* 14 *C* 24	5 15 25	6 16 26	7 17 27	8 18 28	9 19 29	10 20 30	11 21 31	12 22 32	13 23 33
203	20	1.97	205.3	162.9	129.1	102.4	81.2	64.4	51.1	40.5	32.12	25.48
213	21	2.07	198.8	155.1	122.9	97.52	77.33	61.34	48.66	38.57	30.59	24.26
224	22	2.16	186.7	148.1	117.4	93.1	73.82	58.55	46.45	36.82	29.19	23.14
234	23	2.26	178.6	141.6	112.3	89.04	70.6	56.	44.43	35.22	27.91	22.13
244	24	2.36	171.1	135.7	107.6	85.33	67.66	53.66	42.58	33.75	26.75	21.2
254	25	2.46	164.25	130.25	103.3	81.9	64.96	51.52	40.88	32.4	25.68	20.36
264	26	2.56	157.95	125.35	99.34	78.77	62.46	49.53	39.3	31.15	24.69	19.57
274	27	2.66	152.1	120.6	95.66	75.85	60.14	47.7	37.85	30.	23.77	18.85
285	28	2.75	146.66	116.3	92.25	73.15	58.	46.	36.5	28.95	22.92	18.17
295	29	2.85	141.62	112.3	89.	70.62	56.	44.4	35.24	27.93	22.13	17.55
305	30	2.95	136.9	108.55	86.1	68.26	54.13	42.93	34.06	27.	21.4	16.96
325	32	3.15	128.35	101.78	80.72	64.	50.75	40.25	31.93	25.31	20.06	15.9
346	34	3.34	120.8	95.8	75.97	60.24	47.76	37.88	30.05	23.82	18.88	14.97
366	36	3.54	114.	90.47	71.75	56.89	45.11	35.77	28.38	22.5	17.83	14.13
386	38	3.74	108.	85.71	67.97	53.9	42.73	33.89	26.89	21.31	16.89	13.39
407	40	3.94	102.67	81.43	64.58	51.2	40.6	32.2	25.55	20.25	16.05	12.72
427	42	4.13	97.78	77.55	61.5	48.76	38.66	30.66	24.33	19.28	15.28	12.11
447	44	4.33	93.34	74.02	58.7	46.54	36.91	29.27	23.22	18.41	14.59	11.56
468	46	4.53	89.28	70.8	56.15	44.52	35.3	28.	22.21	17.61	13.95	11.06
488	48	4.72	85.56	67.86	53.82	42.67	33.83	26.83	21.29	16.87	13.37	10.6
508	50	4.92	82.14	65.14	51.66	40.96	32.48	25.76	20.44	16.2	12.84	10.18
559	55	5.41	74.67	59.22	46.96	37.23	29.52	23.41	18.58	14.72	11.67	9.25
610	60	5.9	68.45	54.28	43.05	34.13	27.06	21.46	17.03	13.5	10.7	8.48
661	65	6.4	63.19	50.11	39.74	31.51	24.98	19.81	15.72	12.46	9.87	7.83
712	70	6.89	58.67	46.53	36.9	29.25	23.2	18.4	14.6	11.57	9.17	7.27
762	75	7.38	54.76	43.43	34.44	27.3	21.65	17.17	13.62	10.8	8.56	6.78
813	80	7.87	51.34	40.71	32.29	25.6	20.3	16.1	12.77	10.12	8.02	6.36
864	85	8.36	48.32	38.32	30.39	24.09	19.1	15.15	12.02	9.53	7.55	5.98
915	90	8.85	45.63	36.19	28.7	22.75	18.04	14.31	11.35	9.	7.13	5.65
965	95	9.35	43.23	34.28	27.19	21.56	17.09	13.55	10.75	8.52	6.75	5.35
1016	100	9.84	41.07	32.57	25.83	20.48	16.24	12.88	10.22	8.1	6.42	5.09
1118	110	108.2	37.33	29.61	23.48	18.62	14.76	11.71	9.29	7.36	5.83	4.63
1220	120	118.1	34.22	27.14	21.52	17.06	13.53	10.73	8.51	6.75	5.35	4.24
1321	130	127.9	31.59	25.05	19.87	15.75	12.49	9.91	7.86	6.23	4.94	3.91
1423	140	137.7	29.33	23.26	18.45	14.63	11.6	9.2	7.3	5.78	4.58	3.63
1525	150	147.6	27.38	21.71	17.22	13.65	10.82	8.58	6.81	5.4	4.28	3.39
1626	160	157.4	25.67	20.35	16.14	12.8	10.15	8.05	6.38	5.06	4.01	3.18
1728	170	167.3	24.16	19.16	15.19	12.04	9.55	7.57	6.01	4.76	3.77	2.99
1830	180	177.1	22.81	18.09	14.35	11.37	9.02	7.15	5.67	4.5	3.56	2.82
1931	190	187.	21.61	17.14	13.59	10.78	8.54	6.78	5.38	4.26	3.38	2.67

The above numbers (in the body of the table) are mean lengths per turn, in inches.

As previously stated, Table I is based on the use of first grade magnet wire at a temperature of about 140° Fahrenheit. The specific resistance of soft copper at that temperature is 12 ohms per mil-foot, and the resistance per foot of standard sizes of wire on this basis is given by Table II for all sizes that are likely to be used in winding magnets. Now, in order to avoid the difficulty of making tests of the quality of the magnet wire available for winding a given magnet, it is necessary to adjust the current passing through the test winding until the resistance per foot of the winding corresponds with the resistance per foot given by Table II, after the winding has been in circuit for five hours. An approximation sufficiently close for all practical purposes can be obtained by adjusting the current to such a value that the resistance per foot of the wire in the test winding is brought to a value just half-way between the resistance at atmospheric temperature, and that given by the table when the winding has been in circuit one hour. The current necessary to accomplish this, or the more accurate result, should be accurately noted; its value is represented throughout this article by the symbol I_h.

Before doing this, however, the exciting current in the test winding should be adjusted to the value that produces the results desired from the magnet, and this value noted accurately; it is represented throughout this article by the symbol I_x. In the case of a magnet for tractive purposes, the current I_x must be such as to cause the magnet to lift its load promptly and firmly every time the switch controlling the supply of current is closed. Having made this test, the test for coil resistance under working conditions should be made as described.

TABLE II.—Resistance of magnet wire at 140° temperature, Fahrenheit.

Wire No.	Resistance per foot.	Wire No.	Resistance per foot.
4	0.0002875	19	0.009316
5	0.0003625	20	0.01176
6	0.0004571	21	0.014814
7	0.00057662	22	0.018691
8	0.0007268	23	0.023575
9	0.0009168	24	0.0297
10	0.001156	25	0.0375
11	0.0014575	26	0.04725
12	0.001838	27	0.05956
13	0.0023175	28	0.0751
14	0.002922	29	0.09471
15	0.003684	30	0.1194
16	0.004646	31	0.1506
17	0.00586	32	0.1899
18	0.007389	33	0.2395

The number of turns of wire in the test coil will, of course, be known, and the product of this number and the current, I_x, is the required exciting force in ampere-turns. The mean length per turn of wire in the permanent winding will be the same as that in the test winding, subject to minor corrections that may prove necessary in rounding out the final results. Tentatively, at least, the mean length, L_m, will be equal to

$$\frac{G_t + g}{2}$$

in which G_t is the girth of the test coil and g the girth of the bobbin or form in which it was wound. Having the ampere-turns required, the mean length per turn of wire and the voltage that will be applied to the terminals of the coil (or each coil, if there are more than one), the size of wire that must be used in the permanent winding is obtainable by the application of Table I. It may happen, of course (and usually will), that none of the mean length values in the table will be found to correspond with that of the test winding; in that event, the nearest table value may be adopted and the mean length per turn of the permanent winding made to conform to this. In many cases it will be found that both the excitation per volt and the mean length per turn of the test winding will differ from all values in the table; in such a case, the nearest mean length value in the table should be adopted which gives the nearest excitation per volt *in excess* of the desired value.

The table is worked out on the assumption that any two wires drawn to B. & S. gauge and differing in size by ten gauge numbers will have cross-sectional areas differing in the ratio of 1 to 10.163 or 10.163 to 1, according to which wire is considered first. This is not strictly true; the ratio of areas is 10.163 to 1 for Nos. 4 and 14, 10.166 to 1 for Nos. 14 and 24, and 10.16 for Nos. 23 and 33. The differences are obviously too small to be of practical importance, however.

As stated in the note at the head of the table, the ampere-turns per volt in column *a* apply to the wire sizes in line *A* across the top of the table; the ampere-turns per volt in column *b* apply to the wire sizes in line *B*, and those in column *c*, to the wires in line *C*. Thus, if a coil wound with No. 8 wire has a mean length of 45.11 inches per turn, its exciting force will be 366 ampere-turns for each volt at its terminals; a coil of the same mean length but wound with No. 18 wire will have 36 (not 36.6, by the way,) ampere-turns per volt, while a coil of No. 28 wire with the same mean length per turn will yield only 3.54 ampere-turns per volt of applied e.m.f. It may be stated that the table is calculated on the basis of the wire sizes in line *B* and the ampere-turns per volt in column *b*, hence the latter values are not numbers from which decimals have been dropped, but are exact.

TABLE III-a.—For Correcting Length of Magnet Coil.

It	Length of test coil: *Lt*.											
Ih	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2⅝	2¾	2⅞
.4	.95	1.03	1.11	1.19	1.27	1.35	1.43	1.5	1.58	1.66	1.74	1.82
.425	.98	1.06	1.14	1.22	1.31	1.39	1.47	1.55	1.63	1.71	1.8	1.87
.45	1.01	1.09	1.17	1.26	1.34	1.43	1.51	1.6	1.68	1.76	1.85	1.93
.475	1.03	1.12	1.21	1.29	1.38	1.47	1.55	1.64	1.72	1.81	1.9	1.98
.5	1.06	1.15	1.24	1.33	1.42	1.5	1.59	1.68	1.77	1.86	1.95	2.03
.525	1.09	1.18	1.27	1.36	1.45	1.54	1.63	1.72	1.81	1.9	1.99	2.08
.55	1.12	1.21	1.3	1.39	1.48	1.58	1.67	1.76	1.86	1.95	2.04	2.13
.575	1.14	1.23	1.33	1.42	1.52	1.61	1.71	1.8	1.9	1.99	2.09	2.18
.6	1.16	1.26	1.36	1.45	1.55	1.65	1.74	1.84	1.94	2.03	2.13	2.23
.625	1.18	1.29	1.38	1.48	1.58	1.68	1.78	1.88	1.98	2.08	2.17	2.27
.65	1.21	1.31	1.41	1.51	1.61	1.71	1.82	1.92	2.02	2.12	2.22	2.32
.675	1.23	1.34	1.44	1.54	1.64	1.75	1.85	1.95	2.05	2.16	2.26	2.36
.7	1.26	1.36	1.47	1.57	1.67	1.78	1.88	1.99	2.09	2.2	2.3	2.41
.725	1.28	1.38	1.49	1.6	1.7	1.81	1.92	2.02	2.13	2.24	2.34	2.45
.75	1.3	1.41	1.52	1.62	1.73	1.84	1.95	2.06	2.17	2.27	2.38	2.49
.8	1.34	1.46	1.57	1.68	1.79	1.9	2.01	2.13	2.24	2.35	2.46	2.57
.85	1.39	1.5	1.61	1.73	1.85	1.96	2.08	2.19	2.31	2.42	2.54	2.65
.9	1.42	1.54	1.66	1.78	1.9	2.02	2.14	2.25	2.37	2.49	2.61	2.73
.95	1.46	1.58	1.71	1.83	1.95	2.07	2.19	2.32	2.44	2.56	2.68	2.8
1.	1.5	1.63	1.75	1.88	2.	2.13	2.25	2.38	2.5	2.63	2.75	2.88
1.05	1.54	1.67	1.79	1.92	2.05	2.18	2.31	2.44	2.56	2.69	2.82	2.95
1.1	1.57	1.71	1.84	1.97	2.1	2.23	2.36	2.49	2.62	2.75	2.88	3.02
1.2	1.64	1.78	1.92	2.05	2.19	2.33	2.47	2.6	2.74	2.88	3.01	3.15
1.3	1.71	1.85	1.99	2.14	2.28	2.42	2.57	2.71	2.85	3.	3.14	3.28
1.4	1.78	1.92	2.07	2.22	2.37	2.51	2.66	2.81	2.96	3.11	3.25	3.4
1.5	1.84	1.99	2.14	2.3	2.45	2.6	2.76	2.91	3.06	3.22	3.37	3.52
1.6	1.9	2.06	2.21	2.37	2.53	2.69	2.85	3.01	3.16	3.32	3.48	3.64
1.7	1.96	2.12	2.28	2.45	2.61	2.77	2.93	3.1	3.26	3.42	3.59	3.75
1.8	2.01	2.18	2.35	2.52	2.68	2.85	3.02	3.19	3.35	3.52	3.69	3.86
1.9	2.07	2.24	2.41	2.59	2.76	2.93	3.1	3.27	3.45	3.62	3.79	3.96
2.	2.12	2.3	2.48	2.65	2.83	3.	3.18	3.36	3.54	3.71	3.89	4.07
2.1	2.17	2.36	2.54	2.72	2.9	3.08	3.26	3.44	3.62	3.81	3.99	4.17
2.2	2.23	2.41	2.6	2.78	2.97	3.15	3.34	3.52	3.71	3.89	4.08	4.27
2.3	2.28	2.47	2.65	2.84	3.03	3.22	3.41	3.6	3.79	3.98	4.17	4.36
2.4	2.32	2.52	2.71	2.91	3.1	3.29	3.49	3.68	3.87	4.07	4.26	4.46

The above numbers (in the body of the table) are corrected lengths, *Lc*.

TABLE III-b.—For Correcting Length of Magnet Coil.

It	Length of test coil *Lt*.											
Ih	3	3⅛	3¼	3⅜	3½	3⅝	3¾	3⅞	4	4⅛	4¼	4⅜
.4	1.9	1.98	2.06	2.14	2.22	2.3	2.37	2.45	2.53	2.61	2.69	2.77
.425	1.96	2.04	2.12	2.2	2.28	2.36	2.45	2.53	2.61	2.69	2.77	2.85
.45	2.01	2.1	2.18	2.26	2.35	2.43	2.52	2.6	2.68	2.77	2.85	2.94
.475	2.07	2.15	2.24	2.33	2.41	2.5	2.58	2.67	2.76	2.84	2.93	3.02
.5	2.12	2.21	2.3	2.39	2.48	2.56	2.65	2.74	2.83	2.92	3.01	3.09
.525	2.18	2.26	2.36	2.45	2.54	2.63	2.72	2.81	2.9	2.99	3.08	3.17
.55	2.23	2.32	2.41	2.5	2.60	2.69	2.78	2.87	2.97	3.06	3.15	3.23
.575	2.28	2.37	2.46	2.56	2.65	2.75	2.84	2.94	3.03	3.13	3.22	3.31
.6	2.32	2.42	2.52	2.62	2.71	2.81	2.91	3	3.1	3.2	3.29	3.39
.625	2.37	2.47	2.57	2.67	2.77	2.87	2.97	3.06	3.16	3.26	3.36	3.46
.65	2.42	2.52	2.62	2.72	2.82	2.92	3.02	3.13	3.23	3.33	3.43	3.53
.675	2.46	2.57	2.67	2.77	2.88	2.98	3.08	3.19	3.29	3.39	3.49	3.59
.7	2.51	2.62	2.72	2.82	2.93	3.03	3.14	3.24	3.35	3.45	3.56	3.66
.725	2.56	2.66	2.77	2.87	2.98	3.09	3.19	3.3	3.41	3.51	3.62	3.73
.75	2.6	2.71	2.81	2.92	3.03	3.14	3.25	3.36	3.46	3.57	3.68	3.79
.8	2.68	2.8	2.91	3.02	3.13	3.24	3.35	3.47	3.58	3.69	3.8	3.91
.85	2.77	2.88	3.	3.11	3.23	3.34	3.46	3.57	3.69	3.81	3.92	4.03
.9	2.84	2.97	3.09	3.2	3.32	3.44	3.56	3.68	3.8	3.91	4.03	4.15
.95	2.92	3.05	3.17	3.29	3.41	3.53	3.66	3.78	3.9	4.02	4.14	4.26
1.	3.	3.13	3.25	3.38	3.5	3.63	3.75	3.88	4.	4.13	4.25	4.38
1.05	3.07	3.2	3.33	3.46	3.59	3.72	3.84	3.97	4.1	4.23	4.36	4.48
1.1	3.14	3.28	3.41	3.54	3.67	3.8	3.93	4.06	4.2	4.33	4.46	4.59
1.15	3.21	3.35	3.49	3.62	3.75	3.89	4.02	4.16	4.29	4.42	4.56	4.69
1.2	3.28	3.44	3.58	3.72	3.85	3.99	4.13	4.27	4.4	4.54	4.68	4.82
1.25	3.35	3.49	3.63	3.77	3.91	4.05	4.19	4.33	4.47	4.61	4.75	4.89
1.3	3.42	3.56	3.71	3.85	3.99	4.13	4.28	4.42	4.56	4.7	4.85	4.99
1.35	3.49	3.63	3.78	3.92	4.07	4.21	4.36	4.5	4.65	4.79	4.94	5.08
1.4	3.55	3.7	3.85	3.99	4.14	4.29	4.44	4.59	4.73	4.88	5.03	5.18
1.45	3.61	3.76	3.91	4.07	4.22	4.37	4.52	4.67	4.82	4.97	5.12	5.27
1.5	3.67	3.83	3.98	4.13	4.29	4.44	4.59	4.75	4.9	5.05	5.21	5.36
1.6	3.85	3.95	4.11	4.27	4.43	4.59	4.75	4.9	5.06	5.22	5.38	5.53
1.7	3.91	4.08	4.24	4.4	4.56	4.73	4.89	5.05	5.22	5.38	5.54	5.71
1.8	4.02	4.19	4.36	4.53	4.7	4.86	5.03	5.2	5.37	5.54	5.7	5.87
1.9	4.14	4.31	4.48	4.65	4.83	5.	5.17	5.34	5.51	5.69	5.86	6.03
2.	4.25	4.42	4.6	4.77	4.95	5.13	5.31	5.48	5.66	5.83	6.01	6.19

The above numbers (in the body of the table) are corrected lengths, *Lc*.

TABLE III-c.—For Correcting Length of Magnet Coil.

It	Length of test coil: *Lt*.											
Ih	4½	4⅝	4¾	4⅞	5	5⅛	5¼	5⅜	5½	5⅝	5¾	5⅞
.5	3.18	3.27	3.36	3.45	3.54	3.62	3.71	3.8	3.89	3.98	4.07	4.16
.525	3.26	3.35	3.44	3.53	3.62	3.71	3.81	3.9	3.99	4.08	4.17	4.26
.55	3.34	3.43	3.52	3.62	3.71	3.8	3.9	3.99	4.08	4.17	4.27	4.36
.575	3.41	3.51	3.6	3.7	3.79	3.89	3.98	4.08	4.17	4.27	4.36	4.46
.6	3.49	3.58	3.68	3.78	3.87	3.97	4.07	4.16	4.26	4.36	4.46	4.55
.625	3.56	3.66	3.76	3.86	3.95	4.05	4.15	4.25	4.35	4.45	4.55	4.65
.65	3.63	3.73	3.83	3.93	4.03	4.13	4.23	4.33	4.43	4.54	4.64	4.74
.675	3.7	3.8	3.9	4.01	4.11	4.21	4.31	4.42	4.52	4.62	4.72	4.83
.7	3.77	3.87	3.97	4.08	4.18	4.29	4.39	4.5	4.6	4.71	4.81	4.92
.725	3.83	3.94	4.04	4.15	4.26	4.37	4.47	4.58	4.68	4.79	4.9	5.0
.75	3.9	4.01	4.11	4.22	4.33	4.44	4.55	4.66	4.76	4.87	4.98	5.09
.775	4.01	4.07	4.18	4.29	4.4	4.51	4.62	4.73	4.84	4.95	5.06	5.17
.8	4.03	4.14	4.25	4.36	4.47	4.58	4.7	4.81	4.92	5.03	5.14	5.25
.825	4.09	4.2	4.32	4.43	4.54	4.66	4.77	4.88	5.	5.11	5.22	5.34
.85	4.15	4.27	4.38	4.5	4.61	4.73	4.84	4.96	5.07	5.19	5.3	5.42
.875	4.21	4.33	4.44	4.56	4.68	4.8	4.91	5.03	5.15	5.26	5.38	5.5
.9	4.27	4.39	4.51	4.63	4.74	4.86	4.98	5.1	5.22	5.34	5.46	5.57
.925	4.33	4.45	4.57	4.69	4.81	4.93	5.05	5.17	5.29	5.41	5.53	5.65
.95	4.39	4.51	4.63	4.75	4.87	5.	5.12	5.24	5.36	5.48	5.61	5.73
1.	4.5	4.63	4.75	4.88	5.	5.13	5.25	5.38	5.5	5.63	5.75	5.88
1.05	4.61	4.74	4.87	5.	5.12	5.25	5.38	5.51	5.64	5.76	5.89	6.02
1.1	4.72	4.85	4.98	5.11	5.25	5.38	5.51	5.64	5.77	5.9	6.03	6.16
1,15	4.83	4.96	5.09	5.23	5.36	5.5	5.63	5.76	5.9	6.03	6.17	6.3
1.2	4.96	5.07	5.2	5.34	5.48	5.61	5.75	5.89	6.03	6.16	6.3	6.44
1.25	5.03	5.17	5.31	5.45	5.59	5.73	5.87	6.01	6.15	6.29	6.43	6.57
1.3	5.13	5.27	5.42	5.56	5.7	5.84	5.99	6.13	6.27	6.41	6.56	6.7
1.35	5.23	5.37	5.52	5.67	5.81	5.96	6.1	6.25	6.39	6.54	6.68	6.83
1.4	5.33	5.47	5.62	5.77	5.92	6.07	6.21	6.36	6.51	6.66	6.81	6.95
1.45	5.42	5.57	5.72	5.87	6.02	6.17	6.32	6.47	6.62	6.77	6.93	7.08
1.5	5.51	5.67	5.82	5.97	6.12	6.28	6.43	6.58	6.74	6.89	7.04	7.2
1.55	5.6	5.76	5.91	6.07	6.23	6.38	6.54	6.69	6.85	7.	7.16	7.32
1.6	5.69	6.85	6.01	6.17	6.33	6.48	6.64	6.8	6.96	7.12	7.27	7.43
1.65	5.78	5.94	6.1	6.26	6.42	6.58	6.74	6.91	7.07	7.23	7.39	7.55
1.7	5.87	6.03	6.19	6.36	6.52	6.68	6.85	7.01	7.17	7.33	7.5	7.66
1.75	5.96	6.12	6.28	6.45	6.61	6.78	6.95	7.11	7.28	7.44	7.61	7.77
1.8	6.04	6.21	6.37	6.54	6.71	6.88	7.05	7.21	7.38	7.55	7.72	7.88
1.85	6.12	6.29	6.46	6.63	6.8	6.97	7.14	7.31	7.48	7.65	7.82	7.99
1.9	6.2	6.38	6.55	6.72	6.89	7.07	7.24	7.41	7.58	7.75	7.93	8.1
1.95	6.28	6.46	6.63	6.81	6.98	7.16	7.33	7.51	7.68	7.86	8.03	8.21
2.	6.37	6.54	6.72	6.9	7.07	7.25	7.42	7.6	7.78	7.96	8.13	8.31

The above numbers (in the body of the table) are corrected lengths, *Lc*.

TABLE III-d.—For Correcting Length of Magnet Coil.

It	Length of Test Coil: *Lt*.											
Ih	6	6⅛	6¼	6⅜	6½	6⅝	6¾	6⅞	7	7⅛	7¼	7⅜
.5	4.24	4.33	4.44	4.51	4.6	4.69	4.77	4.86	4.95	5.04	5.13	5.22
.525	4.35	4.44	4.53	4.62	4.71	4.8	4.89	4.98	5.07	5.16	5.25	5.34
.55	4.45	4.54	4.64	4.73	4.82	4.91	5.01	5.1	5.19	5.29	5.38	5.47
.575	4.55	4.65	4.74	4.83	4.93	5.02	5.12	5.21	5.31	5.4	5.5	5.59
.6	4.65	4.75	4.84	4.94	5.04	5.13	5.23	5.33	5.42	5.52	5.62	5.71
.625	4.75	4.84	4.94	5.04	5.14	5.24	5.34	5.44	5.53	5.63	5.73	5.83
.65	4.84	4.94	5.04	5.14	5.24	5.34	5.44	5.54	5.64	5.75	5.85	5.95
.675	4.93	5.03	5.14	5.24	5.34	5.44	5.55	5.65	5.75	5.85	5.96	6.06
.7	5.02	5.13	5.23	5.33	5.44	5.54	5.65	5.75	5.86	5.96	6.07	6.17
.725	5.11	5.22	5.32	5.43	5.53	5.64	5.75	5.86	5.96	6.07	6.17	6.28
.75	5.2	5.3	5.41	5.52	5.63	5.74	5.85	5.95	6.06	6.17	6.28	6.39
.775	5.28	5.39	5.5	5.61	5.72	5.83	5.94	6.05	6.16	6.27	6.39	6.49
.8	5.37	5.48	5.59	5.7	5.81	5.93	6.04	6.15	6.26	6.37	6.49	6.6
.825	5.45	5.56	5.68	5.79	5.91	6.02	6.13	6.25	6.36	6.47	6.59	6.7
.85	5.53	5.65	5.76	5.88	5.99	6.11	6.22	6.34	6.45	6.57	6.69	6.8
.875	5.61	5.73	5.85	5.96	6.08	6.2	6.31	6.43	6.55	6.67	6.78	6.9
.9	5.69	5.81	5.93	6.05	6.17	6.29	6.4	6.52	6.64	6.75	6.88	7.
.925	5.77	5.89	6.01	6.13	6.25	6.37	6.49	6.61	6.73	6.85	6.97	7.09
.95	5.85	5.97	6.09	6.21	6.34	6.46	6.58	6.7	6.82	6.95	7.07	7.19
1.	6.	6.13	6.25	6.38	6.5	6.63	6.75	6.88	7.	7.13	7.25	7.38
1.05	6.15	6.28	6.41	6.53	6.66	6.79	6.92	7.05	7.17	7.3	7.43	7.56
1.1	6.29	6.43	6.56	6.69	6.82	6.95	7.08	7.21	7.34	7.47	7.61	7.74
1.15	6.44	6.57	6.7	6.84	6.97	7.11	7.24	7.37	7.51	7.64	7.78	7.91
1.2	6.57	6.71	6.85	6.99	7.12	7.26	7.39	7.53	7.67	7.81	7.94	8.08
1.25	6.71	6.85	6.99	7.13	7.27	7.41	7.55	7.69	7.83	7.97	8.11	8.25
1.3	6.84	6.98	7.13	7.27	7.41	7.55	7.7	7.84	7.98	8.13	8.27	8.41
1.35	6.97	7.12	7.26	7.41	7.55	7.7	7.84	7.99	8.13	8.28	8.43	8.57
1.4	7.1	7.25	7.4	7.54	7.69	7.84	7.99	8.13	8.28	8.43	8.58	8.73
1.45	7.23	7.38	7.53	7.68	7.83	7.98	8.13	8.28	8.43	8.58	8.73	8.88
1.5	7.35	7.5	7.66	7.81	7.96	8.11	8.27	8.42	8.57	8.73	8.88	9.03
1.55	7.47	7.63	7.78	7.94	8.09	8.25	8.4	8.56	8.72	8.87	9.03	9.18
1.6	7.59	7.75	7.91	8.07	8.22	8.38	8.54	8.7	8.86	9.01	9.17	9.33
1.65	7.71	7.87	8.03	8.19	8.35	8.51	8.67	8.83	8.99	9.15	9.31	9.47
1.7	7.82	7.99	8.15	8.31	8.48	8.64	8.8	8.96	9.13	9.29	9.45	9.62
1.75	7.94	8.1	8.27	8.43	8.6	8.77	8.93	9.09	9.26	9.43	9.59	9.76
1.8	8.05	8.22	8.39	8.55	8.72	8.89	9.06	9.22	9.39	9.56	9.73	9.9
1.85	8.16	8.33	8.5	8.67	8.84	9.01	9.18	9.35	9.52	9.69	9.86	10.03
1.9	8.27	8.44	8.62	8.79	8.96	9.13	9.3	9.48	9.65	9.82	9.99	10.17
1.95	8.38	8.55	8.73	8.9	9.08	9.25	9.43	9.6	9.78	9.95	10.13	10.3
2.	8.49	8.66	8.84	9.02	9.19	9.37	9.55	9.72	9.9	10.08	10.25	10.43

The above numbers (in the body of the table) are corrected lengths, *Lc*.

TABLE IV-a.—Linear Space Occupied by Single-Cotton-Covered Wires.

Turns or Layers.	Wire numbers, B. & S. Gauge: 4	5	6	7	8	9	10	11	12	13	14
2	0.432	0.388	0.344	0.308	0.274	0.244	0.216	0.194	0.174	0.16	0.14
3	0.648	0.582	0.516	0.462	0.411	0.366	0.324	0.291	0.261	0.24	0.21
4	0.864	0.776	0.688	0.616	0.548	0.488	0.432	0.388	0.348	0.31	0.28
5	1.08	0.97	0.86	0.77	0.685	0.61	0.54	0.485	0.435	0.39	0.35
6	1.296	1.164	1.032	0.924	0.822	0.732	0.648	0.582	0.522	0.47	0.42
7	1.512	1.358	1.204	1.078	0.959	0.854	0.756	0.679	0.609	0.55	0.49
8	1.728	1.552	1.376	1.232	1.096	0.976	0.864	0.776	0.696	0.63	0.56
9	1.994	1.746	1.548	1.386	1.233	1.098	0.972	0.873	0.783	0.70	0.63
10	2.16	1.94	1.72	1.54	1.37	1.22	1.08	0.97	0.87	0.78	0.7
11	2.38	2.14	1.89	1.69	1.51	1.34	1.19	1.07	0.96	0.86	0.77
12	2.59	2.33	2.07	1.85	1.64	1.47	1.3	1.17	1.05	0.94	0.84
13	2.81	2.52	2.24	2.	1.78	1.59	1.41	1.26	1.13	1.02	0.91
14	3.03	2.72	2.41	2.16	1.92	1.71	1.51	1.36	1.22	1.09	0.98
15	3.24	2.91	2.58	2.31	2.06	1.83	1.62	1.46	1.31	1.17	1.05
16	3.46	3.11	2.75	2.47	2.19	1.95	1.73	1.55	1.39	1.25	1.12
17	3.67	3.3	2.93	2.62	2.33	2.06	1.84	1.65	1.48	1.33	1.19
18	3.89	3.49	3.1	2.77	2.47	2.2	1.95	1.75	1.57	1.44	1.26
19	4.11	3.69	3.27	2.93	2.61	2.32	2.05	1.85	1.66	1.48	1.33
20	4.32	3.88	3.44	3.08	2.74	2.44	2.16	1.94	1.74	1.56	1.4
21	4.53	4.07	3.61	3.24	2.88	2.56	2.27	2.04	1.83	1.64	1.47
22	4.75	4.27	3.78	3.39	3.02	2.69	2.38	2.14	1.92	1.72	1.54
23	4.97	4.46	3.95	3.54	3.15	2.81	2.49	2.23	2.	1.8	1.61
24	...	4.65	4.125	3.69	3.29	2.93	2.59	2.33	2.09	1.87	1.68
25	...	4.85	4.3	3.85	3.43	3.05	2.7	2.43	2.18	1.95	1.75
26	...	5.05	4.47	4.	3.56	3.17	2.81	2.52	2.26	2.03	1.82
27	...	...	4.64	4.16	3.7	3.29	2.92	2.62	2.35	2.11	1.89
28	...	...	4.81	4.31	3.83	3.41	3.03	2.72	2.44	2.19	1.96
29	...	...	4.98	4.46	3.97	3.54	3.13	2.82	2.53	2.26	2.03
30	...	...	5.16	4.62	4.11	3.66	3.24	2.91	2.61	2.34	2.1
31	...	...	...	4.77	4.25	3.78	3.35	3	2.7	2.42	2.17
32	...	...	...	4.93	4.38	3.9	3.45	3.1	2.79	2.5	2.24
33	...	...	...	5.08	4.52	4.02	3.56	3.2	2.87	2.58	2.31
34	...	...	...	...	4.65	4.14	3.67	3.29	2.96	2.65	2.38
35	...	...	...	...	4.79	4.27	3.78	3.39	3.04	2.73	2.45
36	...	...	...	...	4.93	4.39	3.89	3.49	3.13	2.81	2.52
37	...	...	...	...	5.07	4.51	3.99	3.59	3.22	2.89	2.59
38	...	...	...	...	...	4.63	4.1	3.68	3.3	2.97	2.66
39	...	...	...	...	...	4.76	4.21	3.78	3.39	3.04	2.73
40	...	...	...	...	...	4.88	4.32	3.88	3.48	3.12	2.8
41	...	...	...	...	...	5	4.42	3.97	3.56	3.2	2.87
42	...	...	...	...	...	...	4.53	4.07	3.65	3.27	2.94
43	...	...	...	...	...	...	4.64	4.17	3.74	3.35	3.01
44	...	...	...	...	...	...	4.75	4.27	3.83	3.43	3.08
45	...	...	...	...	...	...	4.86	4.36	3.91	3.51	3.15
46	...	...	...	...	...	...	4.97	4.46	4.	3.59	3.22
47	...	...	...	...	...	...	...	4.56	4.09	3.66	3.29
48	...	...	...	...	...	...	...	4.66	4.18	3.74	3.36
49	...	...	...	...	...	...	...	4.76	4.27	3.82	3.43
50	...	...	...	...	...	...	...	4.85	4.35	3.95	3.5
52	...	...	...	...	...	...	...	...	4.52	4.06	3.64
54	...	...	...	...	...	...	...	...	4.7	4.22	3.78
56	...	...	...	...	...	...	...	...	4.87	4.37	3.92
58	...	...	...	...	...	...	...	...	...	4.52	4.06
60	...	...	...	...	...	...	...	...	...	4.68	4.2
62	...	...	...	...	...	...	...	...	...	...	4.34
64	...	...	...	...	...	...	...	...	...	...	4.48

TABLE IV-b.—Linear Space Occupied by Single-Cotton-Covered Wires.

Turns or Layers.	Wire numbers, B. & S. Gauge: 15	16	17	18	19	20	21	22	23	24
6	0.38	0.34	0.31	0.28	0.25	0.23	0.2	0.19	0.17	0.15
7	0.44	0.4	0.36	0.32	0.29	0.27	0.24	0.22	0.2	0.17
8	0.5	0.46	0.41	0.37	0.34	0.3	0.27	0.25	0.22	0.2
9	0.57	0.51	0.46	0.41	0.38	0.34	0.31	0.28	0.25	0.22
10	0.63	0.57	0.51	0.46	0.42	0.38	0.34	0.31	0.28	0.25
11	0.69	0.63	0.56	0.51	0.46	0.42	0.37	0.34	0.31	0.27
12	0.75	0.68	0.61	0.55	0.5	0.46	0.41	0.37	0.34	0.3
13	0.82	0.74	0.66	0.6	0.55	0.49	0.44	0.4	0.36	0.33
14	0.88	0.8	0.71	0.64	0.59	0.53	0.48	0.43	0.39	0.35
15	0.95	0.85	0.76	0.69	0.63	0.57	0.51	0.46	0.42	0.38
16	1.01	0.91	0.82	0.74	0.67	0.61	0.54	0.5	0.45	0.4
17	1.07	0.97	0.87	0.78	0.72	0.65	0.58	0.53	0.48	0.42
18	1.13	1.03	0.92	0.83	0.76	0.68	0.61	0.56	0.5	0.45
19	1.2	1.08	0.97	0.87	0.8	0.72	0.65	0.59	0.53	0.47
20	1.26	1.14	1.02	0.92	0.84	0.76	0.68	0.62	0.56	0.5
21	1.32	1.2	1.07	0.97	0.88	0.8	0.71	0.65	0.59	0.52
22	1.39	1.25	1.12	1.01	0.92	0.84	0.75	0.68	0.62	0.55
23	1.45	1.31	1.17	1.06	0.97	0.87	0.78	0.71	0.64	0.57
24	1.51	1.37	1.22	1.1	1.01	0.91	0.82	0.74	0.67	0.6
25	1.57	1.42	1.27	1.15	1.05	0.95	0.85	0.78	0.7	0.62
26	1.64	1.48	1.33	1.2	1.09	0.99	0.88	0.81	0.73	0.65
27	1.7	1.54	1.38	1.24	1.13	1.03	0.92	0.84	0.76	0.67
28	1.76	1.6	1.43	1.29	1.18	1.06	0.95	0.87	0.78	0.7
29	1.83	1.65	1.48	1.33	1.22	1.1	0.99	0.9	0.81	0.72
30	1.89	1.71	1.53	1.38	1.26	1.14	1.02	0.93	0.84	0.75
31	1.95	1.77	1.58	1.43	1.3	1.18	1.05	0.96	0.87	0.77
32	2.02	1.82	1.63	1.47	1.34	1.22	1.09	0.99	0.9	0.8
33	2.08	1.88	1.68	1.52	1.39	1.25	1.12	1.02	0.93	0.82
34	2.14	1.94	1.73	1.56	1.43	1.29	1.16	1.05	0.95	0.85
35	2.2	2.	1.78	1.61	1.47	1.33	1.19	1.08	0.98	0.87
36	2.27	2.05	1.84	1.66	1.51	1.37	1.22	1.12	1.01	0.9
37	2.33	2.11	1.89	1.7	1.55	1.41	1.26	1.15	1.04	0.92
38	2.39	2.17	1.94	1.75	1.6	1.44	1.29	1.18	1.06	0.95
39	2.46	2.22	1.99	1.79	1.64	1.48	1.33	1.21	1.09	0.97
40	2.52	2.28	2.04	1.84	1.68	1.52	1.36	1.24	1.12	1.
41	2.58	2.34	2.09	1.89	1.72	1.56	1.39	1.27	1.15	1.02
42	2.65	2.39	2.14	1.93	1.76	1.6	1.43	1.3	1.18	1.05
43	2.71	2.45	2.19	1.98	1.81	1.63	1.46	1.33	1.2	1.07
44	2.77	2.51	2.24	2.02	1.85	1.67	1.5	1.36	1.23	1.1
45	2.83	2.56	2.29	2.07	1.89	1.71	1.53	1.39	1.26	1.12
46	2.9	2.62	2.35	2.12	1.93	1.75	1.56	1.43	1.29	1.15
47	2.96	2.68	2.4	2.16	1.97	1.79	1.6	1.46	1.32	1.17
48	3.02	2.73	2.45	2.21	2.02	1.82	1.63	1.49	1.34	1.2
49	3.09	2.79	2.5	2.25	2.06	1.86	1.67	1.52	1.37	1.22
50	3.15	2.85	2.55	2.3	2.1	1.9	1.7	1.55	1.4	1.25
52	3.27	2.96	2.65	2.39	2.18	1.98	1.77	1.61	1.46	1.3
54	3.4	3.08	2.75	2.48	2.27	2.05	1.84	1.67	1.51	1.35
56	3.53	3.19	2.86	2.58	2.35	2.13	1.9	1.74	1.57	1.4
58	3.65	3.31	2.96	2.67	2.44	2.2	1.97	1.8	1.62	1.45
60	3.78	3.42	3.06	2.76	2.52	2.28	2.04	1.86	1.68	1.5
62	3.91	3.53	3.16	2.85	2.6	2.36	2.11	1.92	1.74	1.55
64	4.03	3.65	3.26	2.94	2.69	2.43	2.18	1.98	1.79	1.6
66	4.16	3.76	3.37	3.04	2.77	2.51	2.24	2.05	1.85	1.65
68	4.28	3.88	3.47	3.13	2.86	2.58	2.31	2.11	1.9	1.7
70	4.41	3.99	3.57	3.22	2.94	2.66	2.38	2.17	1.96	1.75

TABLE IV-f.—Linear Space Occupied by Double-Cotton-Covered Wires.

Turns or Layers.	Wire numbers, B. & S. Gauge: 17	18	19	20	21	22	23	24
74	4.	3.67	3.33	3.04	2.78	2.52	2.3	2.07
76	4.11	3.76	3.42	3.12	2.85	2.59	2.36	2.13
78	4.21	3.86	3.51	3.2	2.93	2.65	2.42	2.19
80	4.32	3.96	3.6	3.28	3.	2.72	2.48	2.24
82	4.43	4.06	3.69	3.36	3.08	2.79	2.54	2.3
84	4.54	4.16	3.78	3.45	3.15	2.86	2.61	2.35
86	4.65	4.26	3.87	3.53	3.23	2.93	2.67	2.41
88	4.75	4.36	3.96	3.61	3.3	2.99	2.73	2.47
90	...	4.46	4.05	3.69	3.38	3.06	2.79	2.52
92	...	4.56	4.14	3.77	3.45	3.13	2.85	2.58
94	...	4.66	4.23	3.86	3.53	3.2	2.92	2.63
96	...	4.75	4.32	3.94	3.6	3.27	2.98	2.69
98	...	...	4.41	4.02	3.68	3.33	3.04	2.75
100	...	...	4.5	4.1	3.75	3.4	3.1	2.8
102	...	...	4.59	4.18	3.83	3.47	3.16	2.86
104	...	...	4.68	4.27	3.9	3.54	3.23	2.91
106	...	...	...	4.35	3.98	3.61	3.29	2.97
108	...	...	...	4.43	4.05	3.67	3.35	3.03
110	...	...	...	4.51	4.13	3.74	3.41	3.08
112	...	...	...	4.59	4.2	3.81	3.47	3.14
114	...	...	...	...	4.28	3.88	3.54	3.19
116	...	...	...	...	4.35	3.95	3.6	3.25
118	...	...	...	...	4.43	4.01	3.66	3.31
120	...	...	...	...	4.5	4.08	3.72	3.36
122	...	...	...	...	...	4.15	3.78	3.42

If the winding is to operate at constant potential, as most magnet windings do, the watts dissipated will be exactly proportional to the current passing, and this will be inversely proportional to the length of the coil parallel with the magnet core if the girth and temperature remain constant. The temperature will be unchanged, of course, the value I_h, of the current necessary to produce the working temperature having been ascertained by trial, as previously described. If the girth of the permanent winding cannot be made identical with that of the test winding, the correction in dimensions will be simple. First, the proper length on the hypothesis of unchanged girth must be determined. As the temperature of the coil is a function of the heat dissipated per unit of effective radiating surface, and the radiating surface is approximately proportional to the length of the coil parallel with the core (assuming the girth fixed), the heat dissipated per unit of surface will be approximately proportional inversely to the square of the coil length. Therefore, if the girth of the permanent winding were identical with that of the test winding, the proper length of the permanent coil would be given by the equation.

$$L_t \times \sqrt{\frac{I_x}{I_h}} = L_c \text{ ....} (1)$$

in which L_t is the length of the test coil and L_c the *calculated* length of the permanent coil on the basis of unchanged girth. Table III (divided into four sections, III-a, III-b, III-c and III-d, for convenience in pasting in a data book) gives the corrected coil length, L_c, corresponding to a considerable practical range of test coil lengths, L_t, and ratios of I_x to I_h. If no correction in the mean length per turn is necessary, this set of tables will, of course, give the proper length, L, of the permanent coil, which in such cases is identical with L_c. If a correction in mean length is necessary and is such as to alter materially the girth of the coil, and therefore the radiating surface per unit of length, after making the correction in mean length, as explained in a preceding paragraph, and ascertaining the calculated length of coil, *Lc*, by means of Table III, the final value for the length (*L*) of the permanent coil may be obtained by means of the formula

$$\frac{L_c \times G_t}{G} = L \ldots\ldots\ldots\ldots(2)$$

G being the girth that the permanent coil will have after correcting the mean length per turn, and G_t the girth of the test coil.

For convenience in making corrections in the mean length per turn and the girth of the finished coil, Table IV (divided into IV-a to IV-f inclusive) has been prepared. This gives the depth of coil that will be obtained with different numbers of layers of the standard sizes of magnet wire, single and double cotton covered.

The table is based on the insulation thicknesses used by the Roebling factory, and while the coil depths are given to the second and third decimal places, it will, of course, be understood that this is not intended as an intimation that coils can be wound in practice to any such degree of accuracy, even if the insulation ran absolutely uniform always, which it does not do. The full figures are given in this, as in Tables I and II, merely in order that one may see what the exact theoretical values are. The table has not been made to include very small sizes of wire, for the reason that any approach to accuracy in calculations based on the insulated diameters of such wires is impossible.

For coils wound around a continuously convex surface, such as that of a bobbin for a round magnet core or one of oval cross-section, the mean length per turn of wire is readily obtained by means of the formula

$$g + \pi d = L_m \ldots\ldots\ldots\ldots(3)$$

in which *g* is the girth of the bobbin or former in which the coil is wound, and *d* is the depth of the winding (in inch measure, or whatever unit of linear measurement may be used; not in layers). The girth of the coil will be obtainable by means of the formula

$$g + 2\pi d = G \ldots\ldots\ldots\ldots(4)$$

The mean length per turn in a coil wound on a bobbin of substantially rectangular

TABLE IV-d.—Linear Space Occupied by Double-Cotton-Covered Wires.

Turns or Layers.	Wire numbers, B. & S. Gauge:										
	4	5	6	7	8	9	10	11	12	13	14
2	0.444	0.4	0.356	0.32	0.284	0.252	0.224	0.202	0.182	0.16	0.15
3	0.666	0.6	0.534	0.48	0.426	0.378	0.336	0.303	0.273	0.24	0.22
4	0.888	0.8	0.712	0.64	0.568	0.504	0.448	0.404	0.364	0.32	0.29
5	1.11	1.	0.89	0.8	0.71	0.63	0.56	0.505	0.455	0.4	0.36
6	1.332	1.2	1.068	0.96	0.852	0.756	0.672	0.606	0.546	0.49	0.44
7	1.554	1.4	1.246	1.12	0.994	0.882	0.784	0.707	0.637	0.57	0.51
8	1.776	1.6	1.424	1.28	1.136	1.008	0.896	0.808	0.728	0.65	0.58
9	1.998	1.8	1.602	1.44	1.278	1.134	1.008	0.909	0.819	0.73	0.66
10	2.22	2.	1.78	1.6	1.42	1.26	1.12	1.01	0.91	0.81	0.73
11	2.442	2.2	1.958	1.76	1.562	1.386	1.232	1.111	1.001	0.89	0.8
12	2.664	2.4	2.136	1.92	1.704	1.512	1.344	1.212	1.092	0.97	0.88
13	2.886	2.6	2.314	2.08	1.846	1.638	1.456	1.313	1.183	1.05	0.95
14	3.108	2.8	2.492	2.24	1.988	1.764	1.568	1.414	1.274	1.13	1.02
15	3.33	3.	2.67	2.4	2.13	1.89	1.68	1.51	1.36	1.21	1.1
16	3.55	3.2	2.85	2.56	2.2	2.01	1.79	1.62	1.46	1.3	1.17
17	3.77	3.4	3.03	2.72	2.41	2.14	1.9	1.72	1.55	1.38	1.24
18	4.	3.6	3.2	2.88	2.56	2.27	2.02	1.82	1.64	1.46	1.31
19	4.22	3.8	3.38	3.04	2.77	2.39	2.13	1.92	1.73	1.54	1.39
20	4.44	4.	3.56	3.2	2.84	2.52	2.24	2.02	1.82	1.62	1.46
21	4.66	4.2	3.74	3.36	2.98	2.65	2.35	2.12	1.91	1.7	1.53
22	4.88	4.4	3.92	3.52	3.12	2.77	2.46	2.22	2	1.78	1.61
23	...	4.6	4.09	3.68	3.27	2.9	2.58	2.32	2.09	1.86	1.68
24	...	4.8	4.27	3.84	3.41	3.02	2.69	2.42	2.18	1.94	1.75
25	...	5.	4.45	4.	3.55	3.15	2.8	2.53	2.28	2.03	1.83
26	...	..	4.63	4.16	3.69	3.28	2.91	2.63	2.37	2.11	1.9
27	...	..	4.81	4.32	3.83	3.4	3.02	2.73	2.46	2.19	1.97
28	...	..	4.98	4.48	3.98	3.53	3.14	2.83	2.55	2.27	2.04
29	...	..	...	4.64	4.12	3.65	3.25	2.93	2.64	2.35	2.12
30	...	..	...	4.8	4.2	3.78	3.36	3.03	2.73	2.43	2.19
31	...	..	...	4.96	4.4	3.91	3.47	3.13	2.82	2.51	2.26
32	...	..	...	...	4.54	4.03	3.58	3.23	2.91	2.59	2.34
33	...	..	...	...	4.6	4.16	3.7	3.33	3.	2.67	2.41
34	...	..	...	...	4.8	4.28	3.81	3.43	3.09	2.75	2.48
35	...	..	...	...	4.97	4.41	3.92	3.54	3.19	2.84	2.56
36	...	..	...	...	...	4.54	4.03	3.64	3.28	2.92	2.63
37	...	..	...	...	...	4.66	4.14	3.74	3.37	3	2.7
38	...	..	...	...	...	4.79	4.26	3.84	3.46	3.08	2.77
39	...	..	...	...	...	4.91	4.37	3.94	3.55	3.16	2.85
40	...	..	...	...	...	5.04	4.48	4.04	3.64	3.24	2.92
41	...	..	...	...	...	...	4.59	4.14	3.73	3.32	2.99
42	...	..	...	...	...	...	4.7	4.24	3.82	3.4	3.07
43	...	..	...	...	...	...	4.82	4.34	3.91	3.48	3.14
44	...	..	...	...	...	...	4.93	4.44	4.	3.56	3.21
45	...	..	...	...	...	...	5.04	4.55	4.1	3.65	3.29
46	...	..	...	...	...	...	...	4.65	4.19	3.73	3.36
47	...	..	...	...	...	...	...	4.75	4.28	3.81	3.43
48	...	..	...	...	...	...	...	4.85	4.37	3.89	3.5
49	...	..	...	...	...	...	...	...	4.46	3.97	3.58
50	...	..	...	...	...	...	...	...	4.55	4.05	3.65
52	...	..	...	...	...	...	...	...	4.73	4.21	3.82
54	...	..	...	...	...	...	...	...	4.91	4.37	3.94
56	...	..	...	...	...	...	...	...	...	4.54	4.09
58	...	..	...	...	...	...	...	...	...	4.7	4.23
60	...	..	...	...	...	...	...	...	...	4.86	4.38
62	...	..	...	...	...	...	...	...	...	...	4.53

TABLE IV-e.—Linear Space Occupied by Double-Cotton-Covered Wires.

Turns or Layers.	Wire numbers, B. & S. Gauge:									
	15	16	17	18	19	20	21	22	23	24
7	0.46	0.42	0.38	0.35	0.32	0.29	0.26	0.24	0.22	0.2
8	0.53	0.48	0.43	0.4	0.36	0.33	0.3	0.27	0.25	0.23
9	0.59	0.54	0.49	0.45	0.4	0.37	0.34	0.31	0.28	0.26
10	0.66	0.6	0.54	0.5	0.45	0.41	0.37	0.34	0.31	0.28
11	0.73	0.66	0.59	0.55	0.5	0.45	0.41	0.38	0.34	0.31
12	0.79	0.72	0.65	0.59	0.54	0.49	0.45	0.41	0.37	0.34
13	0.86	0.78	0.71	0.65	0.59	0.53	0.49	0.44	0.41	0.37
14	0.92	0.84	0.76	0.69	0.63	0.58	0.53	0.48	0.43	0.39
15	0.99	0.9	0.81	0.74	0.68	0.62	0.56	0.51	0.47	0.42
16	1.06	0.96	0.86	0.79	0.72	0.66	0.6	0.54	0.5	0.45
17	1.12	1.02	0.92	0.84	0.77	0.7	0.64	0.58	0.53	0.48
18	1.19	1.08	0.97	0.89	0.81	0.74	0.68	0.61	0.56	0.51
19	1.25	1.14	1.03	0.94	0.86	0.78	0.71	0.65	0.59	0.53
20	1.32	1.2	1.08	0.99	0.9	0.82	0.75	0.68	0.62	0.56
21	1.39	1.26	1.13	1.04	0.95	0.86	0.79	0.72	0.65	0.59
22	1.45	1.32	1.19	1.09	0.99	0.9	0.83	0.75	0.68	0.62
23	1.52	1.38	1.24	1.14	1.04	0.94	0.86	0.78	0.72	0.65
24	1.58	1.44	1.3	1.19	1.08	0.98	0.9	0.82	0.75	0.67
25	1.65	1.5	1.35	1.24	1.13	1.03	0.94	0.85	0.78	0.7
26	1.72	1.56	1.4	1.29	1.17	1.07	0.98	0.88	0.81	0.73
27	1.78	1.62	1.46	1.34	1.22	1.11	1.01	0.92	0.84	0.76
28	1.85	1.68	1.51	1.39	1.26	1.15	1.05	0.95	0.87	0.79
29	1.91	1.74	1.57	1.44	1.31	1.19	1.09	0.99	0.9	0.81
30	1.98	1.8	1.62	1.49	1.35	1.23	1.13	1.02	0.93	0.84
31	2.05	1.86	1.68	1.54	1.4	1.27	1.16	1.06	0.96	0.87
32	2.11	1.92	1.73	1.58	1.44	1.31	1.2	1.09	0.99	0.9
33	2.18	1.98	1.78	1.63	1.49	1.35	1.24	1.12	1.02	0.92
34	2.25	2.04	1.84	1.68	1.53	1.4	1.28	1.16	1.05	0.95
35	2.31	2.1	1.89	1.73	1.58	1.44	1.31	1.19	1.09	0.98
36	2.38	2.16	1.95	1.78	1.62	1.48	1.35	1.23	1.12	1.01
37	2.44	2.22	2	1.83	1.67	1.52	1.39	1.26	1.15	1.04
38	2.51	2.28	2.05	1.88	1.71	1.56	1.43	1.29	1.18	1.07
39	2.58	2.34	2.11	1.93	1.76	1.6	1.46	1.33	1.21	1.09
40	2.64	2.4	2.16	1.98	1.8	1.64	1.5	1.36	1.24	1.12
41	2.71	2.46	2.22	2.03	1.85	1.68	1.54	1.4	1.27	1.15
42	2.77	2.52	2.27	2.08	1.89	1.72	1.58	1.43	1.3	1.18
43	2.84	2.58	2.32	2.13	1.94	1.76	1.61	1.46	1.33	1.21
44	2.91	2.64	2.38	2.18	1.98	1.81	1.65	1.5	1.37	1.23
45	2.97	2.7	2.43	2.23	2.03	1.85	1.69	1.53	1.4	1.26
46	3.04	2.76	2.49	2.28	2.07	1.89	1.73	1.57	1.43	1.29
47	3.1	2.82	2.54	2.33	2.12	1.93	1.76	1.6	1.46	1.32
48	3.17	2.88	2.59	2.38	2.16	1.97	1.8	1.63	1.49	1.34
49	3.23	2.94	2.65	2.43	2.21	2.01	1.84	1.67	1.52	1.37
50	3.3	3.	2.7	2.47	2.25	2.05	1.87	1.7	1.55	1.4
52	3.43	3.12	2.81	2.57	2.34	2.13	1.95	1.77	1.61	1.46
54	3.56	3.24	2.92	2.67	2.43	2.22	2.03	1.84	1.67	1.51
56	3.7	3.36	3.03	2.77	2.52	2.3	2.1	1.9	1.74	1.57
58	3.83	3.48	3.13	2.87	2.61	2.38	2.18	1.97	1.8	1.63
60	3.96	3.6	3.24	2.97	2.7	2.46	2.25	2.04	1.86	1.68
62	4.09	3.72	3.35	3.07	2.79	2.54	2.33	2.11	1.92	1.74
64	4.23	3.84	3.46	3.17	2.88	2.63	2.4	2.18	1.99	1.79
66	4.36	3.96	3.57	3.27	2.97	2.71	2.48	2.25	2.05	1.85
68	4.49	4.08	3.67	3.37	3.06	2.79	2.55	2.31	2.11	1.91
70	4.62	4.2	3.78	3.47	3.15	2.87	2.63	2.38	2.17	1.96
72	4.75	4.32	3.89	3.57	3.24	2.95	2.7	2.45	2.23	2.02

TABLE IV-c.—Linear Space Occupied by Single-Cotton-Covered Wires.

Turns or Layers.	Wire numbers, B. & S. Gauge:							
	17	18	19	20	21	22	23	24
72	3.67	3.31	3.02	2.74	2.45	2.23	2.02	1.8
74	3.77	3.4	3.11	2.81	2.52	2.29	2.07	1.85
76	3.88	3.5	3.19	2.89	2.58	2.36	2.13	1.9
78	3.98	3.58	3.28	2.96	2.65	2.42	2.18	1.95
80	4.08	3.68	3.36	3.04	2.72	2.48	2.24	2.
82	4.18	3.77	3.44	3.12	2.79	2.54	2.3	2.05
84	4.28	3.86	3.53	3.19	2.86	2.6	2.35	2.1
86	4.39	3.96	3.61	3.27	2.92	2.67	2.41	2.15
88	4.49	4.05	3.7	3.34	2.99	2.73	2.46	2.2
90	4.59	4.14	3.78	3.42	3.06	2.79	2.52	2.25
92	...	4.23	3.86	3.5	3.13	2.85	2.58	2.3
94	...	4.32	3.95	3.57	3.2	2.91	2.63	2.35
96	...	4.42	4.03	3.65	3.26	2.98	2.69	2.4
98	...	4.51	4.12	3.72	3.33	3.04	2.74	2.45
100	...	4.6	4.2	3.8	3.4	3.1	2.8	2.5
102	...	...	4.28	3.88	3.47	3.16	2.86	2.55
104	...	...	4.37	3.95	3.54	3.22	2.91	2.6
106	...	...	4.45	4.03	3.6	3.29	2.97	2.65
108	...	...	4.54	4.1	3.67	3.35	3.02	2.7
110	...	...	...	4.18	3.74	3.41	3.08	2.75
112	...	...	...	4.26	3.81	3.47	3.14	2.8
114	...	...	...	4.33	3.88	3.53	3.19	2.85
116	...	...	...	4.41	3.94	3.6	3.25	2.9
118	...	...	...	4.48	4.01	3.66	3.3	2.95
120	...	...	...	4.56	4.08	3.72	3.36	3.

cross-section will be greater than the value given by this formula on account of the bulging of the wire away from the core in the parts of the winding which cover the straight surfaces of the bobbin or former. This is also true, and to a greater extent, of the girth of the finished coil.

◆ ◆ ◆

OPERATION OF STORAGE BATTERIES AND BOOSTERS.

BY W. T. FERNANDEZ.

The use of the cadmium auxiliary electrode and recording charts for keeping an accurate record of individual cell and general battery conditions has been described in the AMERICAN ELECTRICIAN, the daily operation of batteries, end-cell switches and boosters, which determines the satisfactory or unsatisfactory results of cadmium readings and chart records will be considered in this article.

The type of end-cell switch generally used in this country is shown in Fig. 1. It consists of a certain number of taps from the high-numbered cells of the battery to a double set of switch contacts from which a brush contact extends to a distributing bar connected to the cables feeding the switchboard. The brush contacts are movable and travel on worm shafts driven by motors mounted on the switch frame work. Each motor may be controlled from a distance by suitable switches. Automatic cut-out switches are installed with the mechanism which stop the main contacts directly on the contacts of the cells to which they may be run up or down, thus preventing faulty contact with any of the cells.

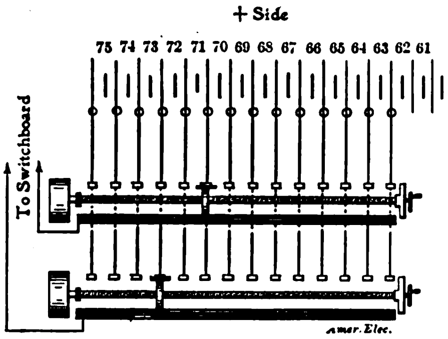

FIG. 1.

As the contact brush travels from one contact to another it must necessarily either open the circuit or short-circuit a cell; this difficulty is overcome by providing a secondary contact of suitable resistance mounted on the same block as the main brush but slightly behind it, so that each cell is close-circuited through that resistance for an instant as the main brush moves forward or backward from cell to cell.

Clutches are provided between the motor and the worm shaft permitting the motor to be disconnected and the worm shaft moved by a hand wheel mounted on its other end, if for any reason the motor fails to operate or become jammed with the brush mid-way between two cell contacts.

The contacts—movable and immovable—must be kept clean and bright with crocus cloth, the moving parts oiled regularly, and if the switches are mounted in a location where the acid fumes reach them, even to a slight extent, the iron parts must be painted with asphaltum paint at least once a year and the copper and brass work rubbed over at frequent intervals with pure sperm or lard oil to prevent corrosion by the acid fumes.

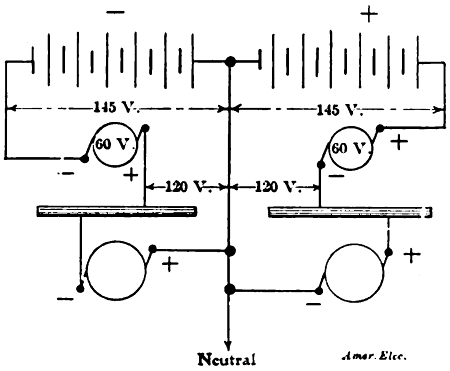

FIG. 2.

The frequent jamming of an end cell switch between two contacts is liable to make the close-circuited cell "slow" in a short time, necessitating a separate charge to that cell. The cause of a switch sticking should always be located at once to prevent possible deterioration of odd end cells throughout the battery. The booster used with a 150-cell three-wire battery usually consists of two 60-volt 36 to 40-kw. direct-current generators direct driven by a motor. They are connected electrically in series with the source of charging current, as shown in Fig. 2.

The source of supply being constant the charging voltage is varied directly by varying the excitation of the booster dynamo field magnets, the available range extending from the voltage of the supply bus-bars to the sum of that voltage plus the e.m.f. of the booster dynamos. With railway and other batteries without a neutral connection, a single machine may be used, as in Fig. 3.

During a charge if for any reason the voltage of the supply bus-bars drops, the charge will, of course, decrease in proportion to the drop, unless the booster fields are more strongly excited to compensate for the drop of the supply bus e.m.f., and if the drop is excessive the battery will discharge through the booster to the supply bus-bars. For example, suppose there are 60 cells on charge on such side of a three-wire system, each cell having an e.m.f. of 2.3 volts, or a total battery e.m.f. of 276 volts. If the e.m.f. of the supply bus-bars is 240 volts and the added e.m.f. of the booster set is 50 volts, the charge is entering the battery under a pressure of 290 volts opposed by 276 volts counter e.m.f. of the battery. Now, suppose the supply bus-bar voltage drops 14 volts; with the booster field rheostats undisturbed there will be no difference of voltage between the battery and booster terminals, and no current flowing in either direction. But if the supply voltage drops any lower under the above conditions, the battery will discharge through the booster to the bus-bars, the rate of discharge depending on the difference in voltage between the battery and booster terminals. A discharge under these conditions may be controlled within certain limits by increasing the dynamo field excitation of the booster, thus raising the booster's terminal voltage to compensate for the drop of the supply voltage. If the discharge cannot be controlled in this manner, the only course left is to cut down the number of cells in circuit as rapidly as possible, regulating the discharge with the booster fields until the field rheostats are at their weakest point, then switching the battery in on the bus-bars, thus cutting out the booster. To attempt to switch the battery directly to the bus-bars with strongly excited fields on the booster would short-circuit the machines and probably burn them out; it is evident, therefore, that the voltage difference between the intake and the output sides of the booster machines should always be as near zero as possible before switching the set in or out between the supply bus-bars and the battery.

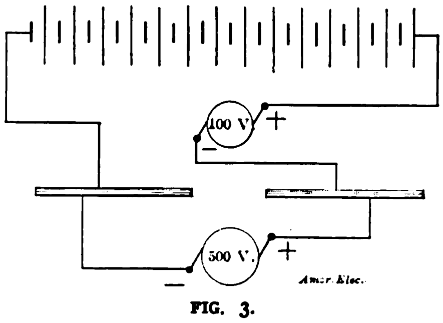

FIG. 3.

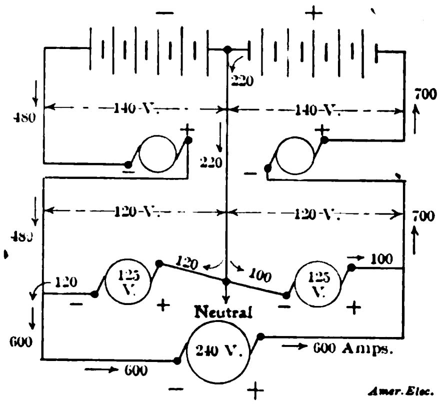

FIG. 4.

Where a battery is connected to a three-wire system but charged from 250-volt generators or rotary converters, an additional piece of apparatus called a compensator is necessary to prevent one side or the other being overcharged or undercharged. The battery discharging on a three-wire system would discharge, on an unbalanced load more out of one side than the other; for example, if the positive side had 3000 and the negative side but 2000 ampere-hours out, when the charge was put back the negative side would be full after 2000 ampere-hours plus about 15 per cent had been charged into it, whereas the positive side would be 1000 ampere-hours short.

With a compensator the rate of charge to one side may be increased so that both sides will reach their maximum e.m.f. at the same time. The apparatus is simple, consisting of two 125-volt machines direct-connected mechanically and connected electrically on the three-wire plan, as shown in Fig. 4. Suppose the negative side has 2000 ampere-hours and the positive side 3000 ampere-hours to go back, and the rate of charge is 600 amperes per side, the field of the negative machine of the compensator set is weakened until that machine receives sufficient current as a motor to drive the positive machine at a high enough speed to furnish the additional current necessary to raise the e.m.f. of the positive side of the battery to its maximum value in the same time required to obtain a similar result on the negative side. The discharge from a three-wire battery may, of course, be balanced with a compensator as well as the charge. Where the unbalance occurs at a definite time and for a definite period, the booster may be used to furnish the additional current required on one side by installing the necessary switches to connect the machines, as shown in Fig. 5.

Where a three-wire battery is in regular operation in conjunction with 250-volt apparatus it is more satisfactory to install a permanent compensator set than to use a booster in that capacity.

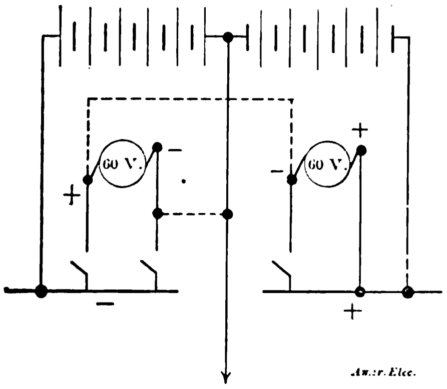

FIG. 5.

A battery without end cells operating on a system which requires the working of all cells or none does not require as much careful attention as one connected to a three-wire system which may require a full or partial discharge of the end cells, in whole or in part, as well as of the main battery.

The requirements of the service may call for a discharge of a certain number of cells at regular periods up to cells 64 to 70, the five cells, 70 to 75, remaining inactive a greater part of the time. As idle cells have a tendency to sulphate under the action of the electrolyte attacking the plates, causing them to harden and decreasing their capacity, it is necessary to discharge the idle cells at regular intervals to keep them in a serviceable condition. When that cannot be done, it is customary to charge them at a normal rate each time the battery is gassed, to work off the sulphate of lead which idleness causes to accumulate on the plates.

The most satisfactory method of keeping account of the battery's capacity where recording charts are not used, is to enter in a book the ampere-hours discharged, add 15 per cent to the total amount discharged and consider the battery full when that number of ampere-hours have been put back into the battery. Where a battery regulates on the bus-bars, which is the usual practice, the book method is not absolutely accurate, but it is a good approximate method of keeping track of the battery's capacity.

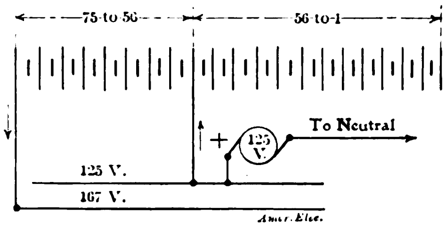

FIG. 6.

In addition to the regular charge put back after each discharge an additional charge, commonly called a gassing charge, is necessary once a week to determine the general condition of the battery and check the book record as to the capacity of the battery. The most satisfactory method of "gassing off" a battery, where end-cell switches are available, is to charge the main battery from the regulating cells downward at the normal rate specified by the manufacturers until the electrolyte boils freely and flows from the center toward both ends of the cells; the electrolyte should change color from limpid to pearl gray and give off numerous bubbles which should explode with a sharp detonation when ignited. Judgment of the correct flow of the electrolyte and proper degree of detonation of the bubbles can be acquired only by experience, but once acquired becomes an excellent guide in keeping track of the cell conditions between the cadmium readings.

Any cell which lags behind its fellows in flowing, detonation of its bubbles or color of its electrolyte should be watched carefully, and if the retrograde action continues, probed, and its specific gravity equalized with that of the other cells. If it remains backward it must be given a separate charge until its action indicates that it has been restored to a healthy condition.

Backward or "slow" cells may be rendered so from several causes: Local short-circuits between the plates, which may be removed by a flat strip of wood moved back and forth between the plates, foreign substances in the electrolyte necessitating refilling the cell, a ground on one cell through a resistance, which will often cause all the cells on that side between the grounded cell and the neutral connection to become "slow" in a period of time depending on the conductivity of the ground and among the end cells, and end cell switches sticking between contacts.

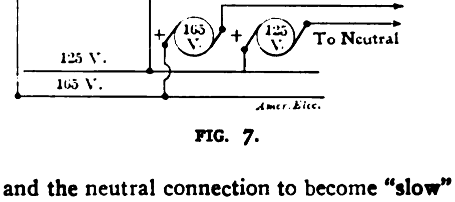

FIG. 7.

After a heavy discharge down to or near the limit of its capacity, a battery should be charged full as soon as possible to prevent the possible reversing of odd cells which may be a trifle "slower" than others connected to them. With the battery practically empty and idle, the higher cells will discharge more or less current into the "slow" cells, frequently reversing them; a prolonged separate charge will usually right a reversed cell.

Buckled plates may be cut out of a cell and straightened by placing them between two flat surfaces and applying pressure to them. The plates should always be well charged, in order to soften them as much as possible, before removal from the cell and charged again when replaced in the cell.

When the main battery has been charged the end-cells from the regulating cell up may be charged direct from the booster by connecting the low side, or side which is connected to the supply bus-bar when charging the main battery, of each booster generator to its respective bus-bar and the high side, or the side which is connected to the battery terminals during main charge may be connected to a spare bus-bar to which is connected the highest end cells. It is necessary, of course, to balance across the two final switches before cutting them in on the bus-bar connected to the high cells.

Cutting out each cell as it is charged, from the highest cell downward, permits a prolonged charge to be put in the cells between the regulating cell and the cell usually used on discharge; the cells mentioned are, as a rule, a little behind the others, and by this method of charging may be kept filled without over-charging the main battery.

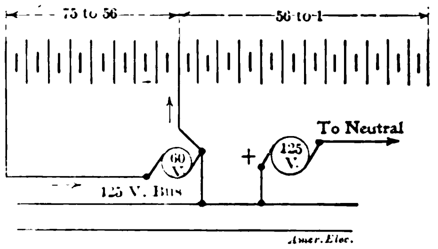

FIG. 8.

The presence of iron in the water supplied to the battery injures the cells; its presence may be detected by adding a few drops of a 10 per cent solution of yellow prussiate of potash to a test tube, two-thirds full, of the electrolyte. If iron is present the solution will turn blue. Where there is any doubt of the freedom from impurities of the water supplied to the cells, distilled water should be used.

A battery equipped with end-cell switches may be used in a number of combinations, and as combination work is more general on three-wire systems than in other work, a series of three-wire battery combinations are shown in Figs. 6, 7 and 8. One side of the battery only is shown; similar connections, of course, are made on the other side of the system. Fig. 6 illustrates a method of boosting through end cells, the e.m.f. of the end cells being added to that of the generator. Care is required that the generator bus-bar does not charge the main battery, as a slow low-rate charge, if persisted in, soon overcharges and injures a well cared-for battery. The extent of boosting is regulated by the number of end cells cut in and an end cell charge put into the cells used when conditions permit.

Fig. 7 illustrates a method of regulating on two bus-bars of different voltages by cutting in one end-cell switch on one busbar with the proper number of cells in circuit and the second end-cell switch on the second bus-bar with the required number of cells to balance with the voltage of the high bus-bar.

Fig. 8 illustrates a method of charging end cells from a booster, at the same time using the main battery for regulation on the bus-bars. The charging current is generated by the booster dynamos and follows a local circuit through the end cells back to the booster generator.

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REDUCING VALVES.

BY R. T. STROHM.

In a large variety of instances it is found desirable to make use of steam at a pressure lower than that at which it is generated. This may occur in a steam plant where the pressure of the steam supplied to the engines must be lower than the boiler pressure; or in paper mills, where it is desired to use low pressure steam in digesters and dryers; or in steam heating systems where a low pressure must be maintained. In many cases, manufacturing plants contain a number of different devices operated by steam, each of which uses, or should use, steam of a certain pressure. The range of pressure thus obtained is often considerable, as, for instance, in a plant where live steam is to be used for heating as well as for operating engines. Manifestly, the engines will not work well with the steam at the pressure of the heating system, and the heating system will not stand high pressure steam. Consequently, there must be some method of reducing the pressure of that portion of the steam which goes into the heating coils. This is accomplished by the use of the regulating or reducing valve.

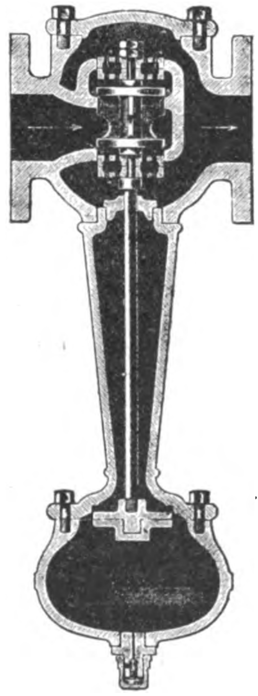

FIG. 1.—DIAPHRAGM TYPE OF REDUCING VALVE.

The action of this valve is, in reality, a simple- wire-drawing of the steam which passes through it, and this wire-drawing effects the desired reduction of pressure, just as in the steam engine any throttling or wire-drawing of the steam during admission causes a drop in pressure between the entering steam and that escaping into the cylinder. The amount of reduction in pressure is, of course, governed by the extent of the wire-drawing. Any desired reduction may be obtained by proper adjustment of the valve. Consequently, in a plant where high-pressure steam is to be used in engines, medium-pressure steam in pumps or auxiliary machinery and low-pressure in heating and drying systems, the reducing valve plays a very important part. Steam may be generated in all the boilers at a pressure equal to that required to operate the engines, and then, by various degrees of throttling by means of reducing valves, the steam necessary to run the auxiliary apparatus may be obtained at the several desired pressures.

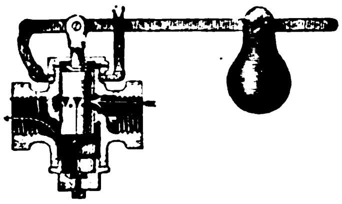

FIG. 2.—SAFETY-VALVE TYPE OF REDUCING VALVE.

A description of the construction and operation of three different types of reducing valves will serve to illustrate the principle of the device. Fig. 1 shows an improved type of steam pressure regulator. As may be seen in the sectional view of the valve, the valve itself consists of two discs fastened to a common stem, the lower end of which is fixed to a diaphragm across the top of the bulb-shaped chamber. The valve thus becomes almost perfectly balanced when under steam pressure. The diaphragm to which the lower end of the stem is connected divides the diaphragm chamber into two compartments, the upper one containing steam at the pressure of the discharge which tends to force the diaphragm downward; the lower one, beneath the diaphragm, is an air chamber into which air is forced by means of a small hand-pump. The pressure of this air obviously tends to force the diaphragm upwards.

Now, it is evident that the discharge pressure depends upon the amount of opening in the main valve. The larger the opening the less the amount of wire-drawing and the greater the pressure on the delivery side. The diaphragm position determines the amount of opening of the valve, and since the position of the diaphragm is determined by the relative pressures on its upper and lower sides, it is evident that by regulating the pressure of the air on the under side, a fixed delivery pressure may be maintained. Increasing the air pressure under the diaphragm increases the discharge pressure and decreasing the air pressure decreases the delivery pressure. This arrangement supports the diaphragm on both sides, distributing the pressure over its entire area, instead of giving pressure on one side only.

In the form of regulating valve shown by Fig. 2, a weight and a lever are used to oppose the action of the delivery pressure and thus determine the valve opening. The weight and lever are external to the valve body, and the pressure at the delivery is changed by altering the position of the weight.

The third type, illustrated by Fig. 3, is of the diaphragm and balanced valve class also, and is controlled and operated by the movement of the diaphragm. This diaphragm is subject not only to the pressure of the steam on the low pressure side of the valve, but also to the action of external springs through the agency of toggle joints. By the adjustment of the spring tension a definite relation between the discharge pressure and the external pressure may be obtained.

The steam from the boiler or other supply enters the reducing valve at *A*, and after passing through the valve, is discharged at *B*. Suppose that steam is turned on for the first time, and that the outlet *B* is connected to an engine. At the moment of admitting steam to the valve, there is no pressure on the discharge side of the valve. The tension in the springs *J*, therefore, will have forced the valve *H* open against the slight resistance of the diaphragm, the amount of opening depending upon the tension of the springs. The steam passing through the valve *H* is throttled, and thereby reduced in pressure. The reduced pressure is immediately transferred, by means of the port *E*, to the chamber *D* beneath the diaphragm and because of its large area the diaphragm is forced upward to some extent, against the resistance of the external springs *J*, and partly closes the valve *H*. This will further reduce the steam pressure at the discharge side of the valve, causing a consequent movement of the diaphragm downward, which opens *H* slightly. A balance is thus quickly established between the force acting upward on the diaphragm, caused by the discharge steam pressure and the force act-

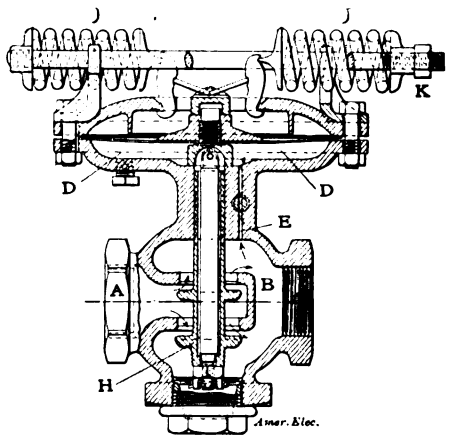

FIG. 3.—DIAPHRAGM AND BALANCED VALVE TYPE OF REDUCING VALVE.

ing downward on the diaphragm, caused by the spring tension. Consequently, if the discharge pressure remains constant the valve will be stationary, but any alteration in the discharge pressure will cause a certain movement of the valve until a new state of equilibrium is restored.

The pressure of the steam on the delivery or discharge side of the valve is regulated by the adjustment of the tension in the springs, which is quickly accomplished by means of the nut *K*. Since the springs act to open the valve *H*, an increase in the tension of the springs means an increased discharge pressure.

The action of the reducing valve is not simply that of lessening the pressure of the steam. The wire-drawing or throttling is accompanied by superheating, in case the steam is dry, or at least in drying it to some extent if it is initially wet. This statement does not mean that the reducing valve superheats the steam above the initial condition of the entering steam. It means that if dry steam is passed through a reducing valve and subjected to throttling action, the discharge steam will be superheated or will possess a temperature higher than the boiling point of water under the pressure on the delivery side of the valve. And i the steam is wet, some of the moisture will be re-evaporated by the wire-drawing.

This point may be made clear by the use of an actual example. Suppose that a pound of steam at an absolute pressure of 100 lbs. is passed through a reducing valve, so that the discharge pressure is 40 lbs. absolute, and for convenience let the steam be initially dry and saturated, and the effects of radiation be neglected. On entering the valve the steam contains 1181.87 heat units. The wire-drawing does not alter the steam weight, so there is one pound of steam both before and after the reduction of pressure. But, one pound of steam at 40 pounds absolute contains but 1163.43 heat units, so that if the steam on the discharge side were saturated steam, it is evident that 18.44 heat units must be accounted for in some manner. The radiation could not have amounted to this much of a loss; the valve and fittings could not absorb it, or they would in time grow intensely hot. The explanation of the disposition of this heat is that the 18.44 heat units remain in the pound of steam at the discharge pressure, and cause it to be superheated, so that its temperature is much higher than 267 degs. Fahr., which is the temperature of saturated steam at 40 lbs. absolute pressure.

The argument has been put forth that dry saturated steam, expanding even under perfect conditions and performing work, will condense somewhat, and that in consequence of this fact there must be condensation in passing through the reducing valve. It is quite true that if saturated steam be allowed to expand in a non-conducting cylinder, and do work, it will condense somewhat. But the steam in expanding in the reducing valve does no external work, and consequently is not called upon to give up any of its store of heat energy to perform external work. The increase in volume which occurs is due to free expansion, or expansion without the performance of external work of any kind, and hence requires no expenditure of heat energy for the overcoming of external resistance.

However, since boilers do not furnish perfectly dry steam, and since radiation losses introduce a certain amount of condensation, there are water globules in the steam that pass through the valve. The wire-drawing of wet steam has an erosive effect upon the valve and its seat, and this erosion is greater as the wire-drawing is greater. Consequently, a good valve should possess working parts of a durable material, and should allow these parts to be replaced at comparatively small cost when too much cut and worn to give good service.

While it is true that the discharge pressure can be varied by adjusting the tension of the diaphragm spring, yet the valve should be designed for a certain definite range of pressure. That is, the same size of valve should not be expected to give all the desired reductions. For if a valve of too great size is used for a considerable reduction, it will be necessary to give it very little lift, and consequently the degree of erosion due to wire-drawing is much increased. Not only does the larger valve cost more, but it is more quickly worn out because of its use to obtain a great reduction. A smaller valve with greater lift, and of less cost, would be better and more economical.

Obviously, to cause wire-drawing, the valve opening will be slight. Hence, to insure satisfactory operation of the reducing valve, it is necessary that all foreign matter be kept out of the valve. In installing new pipe lines on which regulating valves must be used, they should be thoroughly cleaned of all chips, scale, pieces of gasket, and so on, by blowing steam through them before putting in the valves. The additional precaution is frequently taken of placing a strainer of wire gauze on the inlet side of the valve, which effectually arrests any solid matter.

The simpler the construction of the valve, the less liable it will be to become inoperative, and the more readily it can be replaced should it fail to work. A good valve should be so designed that all of its working parts can be quickly and easily examined, which means that all should be quite accessible without the necessity of removing the valve from the pipe line. The location of the springs and toggles outside the valve casing in Fig. 3 removes these springs from the action of the steam and puts many of the working parts in plain view, which is a desirable feature. On the other hand, the complete enclosure of the mechanism within the valve casing, as in Fig. 1, prevents any injury to the working parts such as might occur to the type shown in Fig. 3.

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Coal Storage Under Water.—It has been estimated that at least one-fifth of the power in coal is lost unnecessarily by the method of storage. Coal stored under water, it appears from recent experiments made in England, loses an inappreciable amount of its calorific value compared with that lost by the alternate method of storage with access to air.—*Exchange.*

INDICATOR DIAGRAMS.

BY CHAS. L. HUBBARD.

In a previous article the use of the diagram for detecting the action of the engine valves was discussed. Another use is in the determination of losses in the cylinder due to leaky valves and cylinder condensation. The amount of these losses may be found by weighing the water fed to the boiler, or by condensing the exhaust steam for a given length of time, and then substracting from this the amount shown as doing useful work by the indicator diagram. The difference between the water consumption shown by the actual weighing of the feed water and by computation from the card will give the losses due to leakage and condensation.

The diagram shows by direct measurement the pressure and volume at any point in the stroke of the piston. The weight per cubic foot for any given pressure may be taken directly from a steam table. The method, then, of finding the weight of steam for any point in the stroke is to find the volume in cubic feet, including the clearance and piston displacement up to the given point, which must be taken at cut-off or later, and to multiply this by the weight per cubic foot corresponding to the pressure at the given point measured on the diagram. This will give the weight of steam in the cylinder.

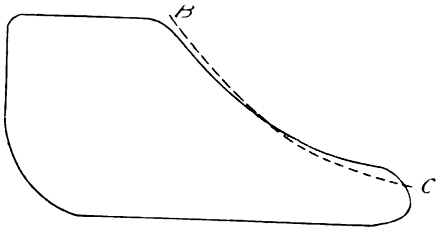

FIG. 1.

As this weight includes the steam used for compression, it must be corrected as follows to obtain the weight used per stroke: Take some point on the compression curve and measure its absolute pressure. Then compute the weight of steam to this point and subtract this weight from the weight of steam to the point taken in the expansion curve already computed; the result will be the weight of steam used per stroke.

The best point on the expansion curve to use for this purpose is that just before release. This is true for two reasons: First, the maximum amount of leakage has taken place, and, second. a certain part of the steam which is condensed during admission and the first part of the stroke is re-evaporated into steam and does useful work toward the latter part of the stroke. This is shown in Fig. 1, in which the solid line represents the actual expansion curve, and the broken line *B—C*, the theoretical expansion curve. The actual curve falls below the theoretical curve during the first part of the stroke, showing condensation and drop in pressure, and rises above it during the latter part of the stroke, showing re-evaporation and rise in pressure above that shown by the theoretical line.

The actual computation of the steam con-

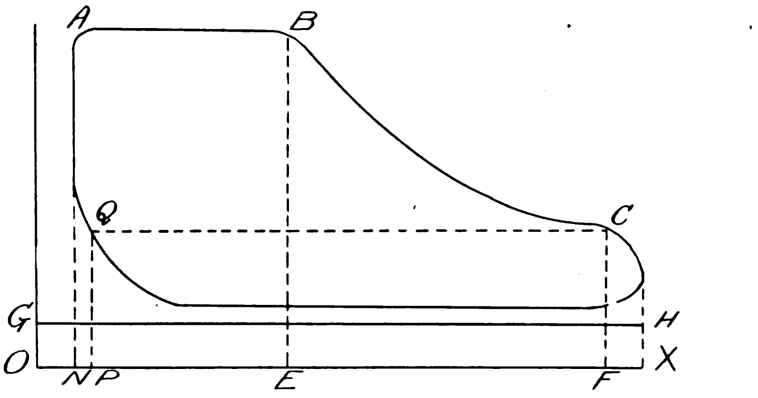

FIG. 2.

sumption from an indicator diagram is best illustrated by working a practical example. Let Fig. 2 represent a diagram taken from a 20-in. by 36-in. engine running at a speed of 80 r.p.m. The card was taken with a 40-pound spring. By measurements the mean ordinate will be found to be 0.91 inch, and the mean effective pressure $= 0.91 \times 40 =$ 36.4 pounds. The indicated horse-power is

$$I.\ H.\ P. = \frac{36.4 \times 3 \times 314 \times 160}{33{,}000} = 166 + .$$

In Fig. 2 *G—H* **is the atmospheric line, and** *O—X* the line of zero pressure so drawn that $O—G = 14.7$ pounds. *O—N* is the clearance volume, which is 8 per cent of the piston displacement. The line *P—Q* is drawn from *O—X* to some point on the compression line. From the point *C* on the expansion line just before release, the line *C—F* is drawn perpendicular to *O—X*. Then measuring from the diagram we have:

$O—X = 3.24$ inches.
$O—F = 3$ inches.
$O—P = 0.375$ inches
$C—F = 0.795$ inches.
$P—Q = 0.795$ inches.

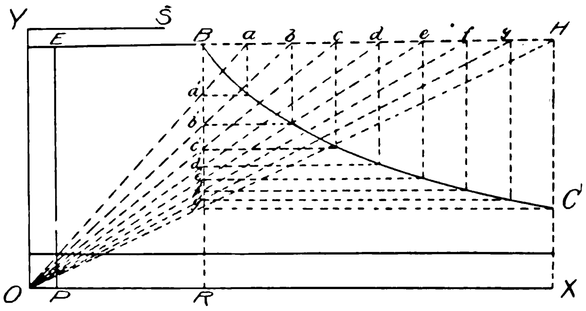

FIG. 3.

The length of stroke is 36 inches, or three feet, and the length of the diagram 3 inches. Then, 1 inch in length on the card corresponds to 1 foot of the stroke. The scale of the spring used is 40, so that one can easily reduce the above dimensions to pounds pressure, and to feet, which gives the following results:

$O—X = 3.24$ feet.
$O—F = 3$ feet.
$O—P = 0.375$ feet.
$C—F = 31.8$ pounds.
$P—Q = 31.8$ pounds.

The area of the piston is 314 square inches, or 2.18 square feet. We can now find the volume of steam at any point of the stroke. When the piston is at *C* the volume is $2.18 \times 3 = 6.54$ cubic feet. When the piston is at *Q*, the volume is $2.18 \times 0.375 = 0.8175$ cubic feet. A steam table shows that the weight of one cubic foot of steam at 31.8 pounds absolute is 0.0777 pound, so that the weight of steam in the cylinder when the piston is at *C* will be $6.54 \times 0.0777 = 0.5081$ pound, and the weight of steam present when the piston is at *Q* will be $0.8175 \times 0.0777 = 0.0635$ lb. The weight of steam in the cylinder at release is 0.5081 pound and the weight kept for compression is 0.0635 pound. The weight exhausted per stroke is therefore $0.5081 - 0.0635 = 0.4446$ pound. This quantity multiplied by the number of strokes per hour will give the weight of steam to be accounted for by the diagram, and this subtracted from the actual weight of feed water used during this time will give the wastes due to condensation and leakage.

There are different methods of constructing the theoretical curve referred to in Fig. 1. One of the simplest is illustrated by Fig. 3. First draw *P—X* equal to the length of the stroke, and *O—P* equal to the clearance, shown as a percentage of the piston displacement. Draw *O—Y* and *P—E* perpendicular to *O—X* and draw *Y—S* parallel to *O—X*, and at a height corresponding to the boiler pressure. The line of initial pressure *E—B* is then drawn parallel to *Y—S* and is usually taken at from 90 per cent to 95 per cent of the boiler pressure if there is no special cause for loss. Then take *E—B* as the portion of the stroke at which steam is admitted. The theoretical expansion line is considered as a hyperbolic curve with *O—X* and *O—Y* as asymptotes. To construct the curve, draw the line *E—B—H* parallel to the atmospheric line, and *X—H* and *R—B* perpendicular to it; then make dots at *a, b, c, d, e, f* and *g* on the line *B—H* and connect them with the point *O*. From the points where the lines *O—a, O—b, O—c*, etc., intersect the line *R—B*, draw lines parallel to *B—H* until they meet perpendiculars from *a, b, c, d, e, f* and *g*. The points of intersection of these lines are points on the hyperbolic curve *B—C*. Enough of these points must be used to determine the curve clearly.

Lessons in Practical Electricity

E.M.F. AND ALTERNATING CURRENT.

It has been explained in a previous Lesson[*] that if a loop of conductive material be mounted on a shaft located midway between two magnet poles, as shown in Fig. 1, and the shaft be rotated, an e.m.f. will be induced in the two sides, *a* and *b*, of the conductor as they sweep past the magnet pole-faces. If the rotation be clockwise, as indicated by the arrows in Figs. 1, 2, 3 and 4, the e.m.f. induced in the loop during its passage from the position of Fig. 1 to the position of Fig. 3 will be in the direction indicated by the arrows on the loop in Fig. 2. When the loop reaches the position shown in Fig. 3 the e.m.f. will have died to zero, and rotation from this position back to the position shown in Fig. 1 will induce an e.m.f. in the opposite direction with relation to the conductor material, as indicated by the arrows on the conductor loop in Fig. 4, which shows the loop midway between the position of Fig. 3 and that of Fig. 1.

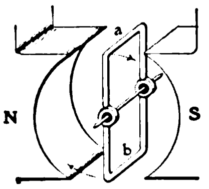

FIG. 1.

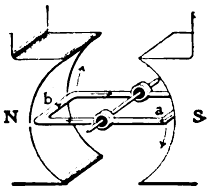

FIG. 2.

It was also explained that this e.m.f., which is in first one direction and then the other within the conductor, varies gradually from zero in the position of Fig. 1 to maximum in the position of Fig. 2; then falls to zero as the loop is brought to the position of Fig. 3; rises to maximum in the opposite direction, in the position of Fig. 4, and again falls to zero as the loop is rotated around to the original position of Fig. 1. This variation in e.m.f. may be made clearer by reference to Fig. 5, where the dots represent one side of the conductor loop, say, the length *b*, in successive positions between that shown by Fig. 1 and that shown in Fig. 3. It will be obvious that with a magnetic field of uniform density, indicated roughly by the horizontal dotted lines, the wire will cut fewer lines passing from position 1 to position **2** than it will in passing from 2 to 3, the number of lines cut in passing from one position to the next increasing as the conductor approaches position 9 opposite the center of

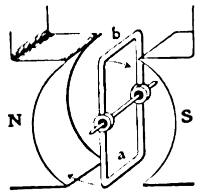

FIG. 3.

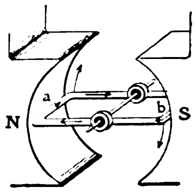

FIG. 4.

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[*] May, 1902.

the pole-face. After passing this point, the number of lines cut during each increment of motion grows less and less, the decrease step by step being the same that would be observed if the conductor had been stopped at position 9 and returned to position 1. If it be assumed that the magnetic field contains 2,000,000 lines of force and that the actual distribution is absolutely uniform, the number of lines cut in passing from one position to the next will be as stated in Table I herewith. If the conductor loop be revolved at the rate of 62½ revolutions per second, each of the active sides, *a* and *b*, will move from one position to the next (Fig. 5) in 1-2000 of a second, and the rate of cutting the lines of force will be 2000 times the number of lines cut during that movement.

TABLE I.

Between positions.	Lines of force.	Between positions.	Lines of force.
1 and 2	19,210	9 and 10	195,090
2 and 3	56,910	10 and 11	187,590
3 and 4	92,410	11 and 12	172,890
4 and 5	124,360	12 and 13	151,540
5 and 6	151,540	13 and 14	124,360
6 and 7	172,890	14 and 15	92,410
7 and 8	187,590	15 and 16	56,910
8 and 9	195,090	16 and 17	19,210

The e.m.f. generated by cutting lines of force is equal to the number of lines cut per second divided by 100,000,000. Consequently, the succession of e.m.f.'s generated in one wire during the half revolution represented in Fig. 5 will be as given in Table II. If these e.m.f.'s be plotted in the shape of a curve the curve will have the shape shown in Fig. 6, where the horizontal distances represent parts of a second and the vertical distances the e.m.f. generated by the wire in passing from one position to the next. The straight horizontal line is the zero line, and the part of the curve above the line indicates the variation of e.m.f. in one direction, which is usually considered positive, and the part of the curve below the line indicates the variation in the opposite direction, usually considered negative. Such an e.m.f. is termed an alternating e.m.f., and the current which it produces in a circuit is called alternating current, because the polarity of the e.m.f. and current in all parts of the circuit alternates. The e.m.f. curve without the ordinates is reproduced in Fig. 7. This is called a sine curve or wave, and is the basis of all alternating current and e.m.f. diagrams.

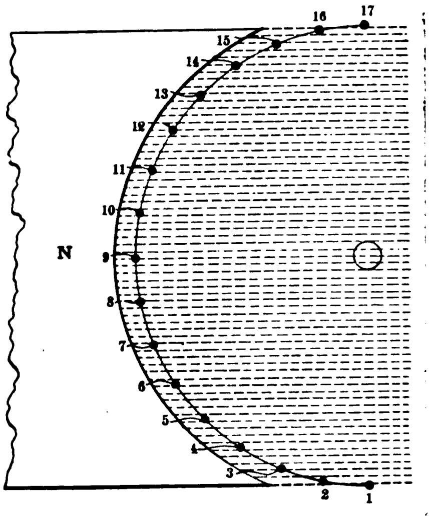

FIG. 5.

If the conductor loop shown in Figs. 1 to 4 inclusive be opened at one end of the shaft and the ends carried to rings against which brushes of conductive material are arranged to rub, as shown in Fig. 8, a closed circuit, *w*, connected to these brushes will carry an alternating current when the loop is revolved between the magnet poles, the strength of the current rising, falling and reversing similarly to that of the e.m.f., as just described. The rotating loop and the collector rings, as they are termed, must, of course, be insulated from the shaft, which would otherwise short-circuit the system. This insulation is represented by the heavy black parts of the diagrams.

TABLE II.

Between positions.	E.M.F.	Between positions.	E.M.F.
1 and 2	0.3842 volts	9 and 10	3.9018 volts
2 and 3	1.1382 volts	10 and 11	3.7518 volts
3 and 4	1.8482 volts	11 and 12	3.4578 volts
4 and 5	2.4872 volts	12 and 13	3.0308 volts
5 and 6	3.0308 volts	13 and 14	2.4872 volts
6 and 7	3.4578 volts	14 and 15	1.8482 volts
7 and 8	3.7518 volts	15 and 16	1.1382 volts
8 and 9	3.9018 volts	16 and 17	0.3842 volts

The armature of a simple alternating-current generator would be wound with a single coil such as that shown in Fig. 8, if the machine had only two poles, but the coil would have a large number of turns. In actual practice alternating-current generators are always multipolar machines, and a machine to generate a simple alternating current usually has as many coils on the armature as there are poles on the field-magnet, the coils being all connected in a single circuit to a single pair of collector rings and arranged on the armature so that at any given moment during the revolution of the armature every coil occupies the same position with relation to the field-magnet poles as that of every other coil. This is necessary in order that the different coils shall not act in opposition to each other.

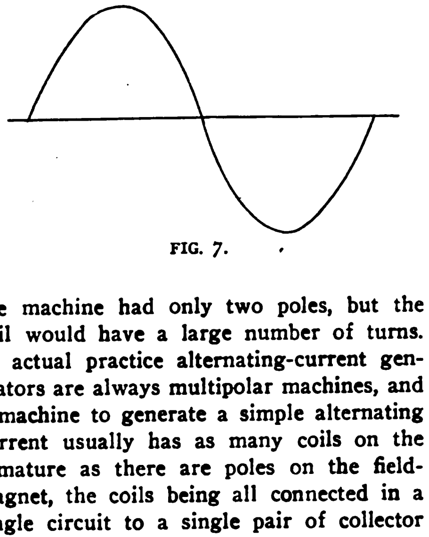

FIG. 7.

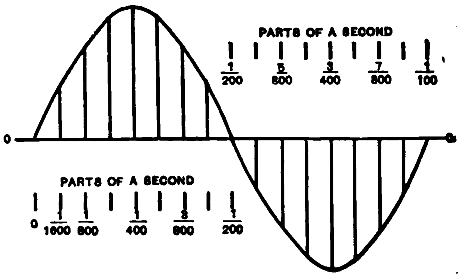

FIG. 6.

The reversals of e.m.f. and current in ordinary alternating-current generators occur as rapidly as 250 or 260 times per second in some cases, the frequency of reversal ranging from this figure down as low as 50 times per second. A reversal occurs, of course, every time the e.m.f. changes from positive to negative and from negative to positive. In Fig. 7, for example, a single reversal is indicated in the center of the diagram, and if the diagram were continued a reversal would be indicated at each of the points where the curve crosses the horizontal line. Two reversals are termed a cycle. It makes no difference whether one considers a cycle to begin when the e.m.f. curve is at the horizontal or zero line, or when it is maximum, or at some other point; a cycle comprises the succession of changes which occur from any one point on the curve to the next point where the curve indicates the same character of e.m.f. or current. For example, in Fig. 9 one may consider that part of the curve between the points *A* and *a* to comprise a cycle, or that part between *B* and *b* to comprise a cycle, or that part lying between *C* and *c* or *D* and *d*. It is customary, however, to consider a cycle as beginning at zero, so that the curve in Fig. 9 represents two complete cycles.

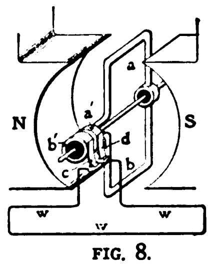

FIG. 8.

The number of cycles per second is termed the frequency of the e.m.f. or current. The standard frequencies are 25, 30, 60 and 125 cycles per second. The frequency of a current or e.m.f. is sometimes referred to in terms of "alternations" per minute; a cycle comprises two alternations, so that a frequency of 25 cycles per second is equivalent to 3000 alternations per minute, and a frequency of 60 cycles per second is equivalent to 7200 alternations per minute.

In alternating-current apparatus and circuits, the e.m.f. available for work is not the maximum e.m.f., but the geometrical average of the e.m.f. values between zero and maximum. On the basis of the sine curve, this average is 0.7071 of the maximum e.m.f. and is termed the effective e.m.f. (in Great Britain it is customary to refer to this value as the "root mean square" value, meaning the square root of the mean squares of the e.m.f. values). In speaking of alternating-current voltages, therefore, the effective e.m.f. is always meant, and it is this e.m.f. which is indicated by measuring instruments. The fluctuations of current are obviously too rapid for the needle of any instrument, however sensitive, to follow, and the instrument therefore indicates the geometrical mean of the fluctuating values.

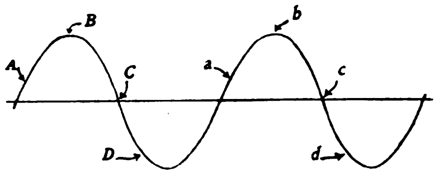

FIG. 9.

Letters on Practical Subjects

The Fire Underwriters' Rules.

To the Editor, American Electrician:

There are some inconsistencies in the requirements of the Fire Underwriters relating to electrical construction as compared with other possible sources of fire, to which I would like to call attention. Every one who has done electrical work under these rules is familiar with the commendable assiduity with which the inspector "camps on the trail" of the wireman, and the wisely rigid rules governing the materials to be used and the method of using them are also familiar to those who are practically concerned with construction work. But did any of your readers ever see any insurance rules demanding that a metallic mat of certain dimensions should surround a wood or coal stove, instead of a rag carpet? Who ever heard of an inspector being on hand to note whether the top of a hot air furnace was within one-half inch or 16 inches of wooden joists above it; or whether the asbestos mat (if one was put in) above the furnace was 1-32 inch or ½ inch thick; or whether the air ducts of this same furnace had a double insulating wall or simply a thin, single metallic wall lying bare against the studding and lathing? Was a carpenter ever required to keep sheathing and rafters clear of a brick flue so that the upper part might settle along with the lower and not leave a good, wide fire leak just under the roof? No; but the electrician's wires, placed *first* and afterwards crossed by a lot of water pipes, have to be moved as soon as the inspector finds the violation of rules, while nothing is said to the plumber and no one considers compensating the wireman for his extra work. We are required (justly) to use insulation on electric wires of sufficient resistance to stand 15 to 90 times the voltage that the wires will ever carry, but where is there a rule requiring that matches be kept in an air-tight non-combustible box having walls of a certain strength? And coming a little nearer home, have the Underwriters ever formulated regulations stipulating that lightning rods must be kept *off* buildings and, in rural districts, erected on poles of certain heights located certain distances from the dwellings or other buildings to be protected?

Now this letter is not written in any spirit of complaint against the restrictions as to electrical work; it is not claimed that since other classes of work are not regulated therefore the electrical work should go scot free. But it *is* my opinion that the efforts of the Fire Underwriters to minimize fire risks should not be concentrated on our class of work to the exclusion of almost everyone else, but that all other branches of construction should be controlled, and the workers in those branches made to face their responsibilities both as to their own work and the relation between that and electrical work. All we ask is fair play.

ROY C. JACKSON.

Los Angeles, Calif.

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Testing Defective Armatures.—A Problem in Broken Circuits.

To the Editor, American Electrician:—

Your readers are probably familiar with the rather elaborate methods employed by most manufacturers of electrical machinery for testing out defects in armatures. One of the most widely used is the transformer method, in which a laminated core is employed of such shape that when it is applied to the periphery of the armature core the latter completes its magnetic circuit. This involves considerable paraphernalia, and is seldom a convenient method to use around a repair shop. The accompanying diagram (Fig. 1) represents a modified transformer method that has been used by me under widely varying conditions and always with satisfaction. On an old transformer core (having a closed magnetic circuit) is wound a few turns of coarse wire, *s*, and over this is wound a graduated winding of finer sizes of wire. This latter winding is connected in series with the coarse-wire winding,* and is shown in the drawing extending from the post *p* to the other post indicated by the same letter; taps are led out to a row of intermediate posts, as indicated. The size of wire changes with each section, *a, b, c,* and *d,* and the number of turns also changes, the section *d* having the fewest number of turns and the largest size of wire (except that in the section *s*). From an ordinary alternating-current circuit, leads are brought to a double-pole switch, and on the other side of this switch an incandescent lamp, *L*, is connected permanently in series with a flexible lead terminating at the connecting plugs *e;* this and the plug *f* fit into holes in the posts *p* to *p*. Three flexible leads are carried out from the coarse-wire winding *s*, and terminate at test plugs *T* having insulated handles. Some preliminary testing is necessary for each case in order to find out which pair of plugs, *T*, should be used, and in which pair of posts the plugs *e* and *f* should be inserted. If testing for an open coil in an armature, the outer two of the three *"T"* plugs should be put in firm contact with two adjacent commutator bars where the coil is known to be good, and the plugs *e* and *f* should be put in two posts which will cause the lamps *L* to glow faintly but distinctly. Then by trying each pair of adjacent bars all around the commutator the two to which the open coil is connected will finally be reached and then the lamp will fail to glow because the higher resistance in the secondary circuit will reduce the current flowing in the lamp or primary circuit. In testing for a short-circuited coil, the plugs are adjusted so that when two *T* plugs are on two commutator bars connected to a good coil the lamp will just remain dark; then when the short-circuited bars are reached the lamp lights up. The condition of "just" remaining dark may be determined by working backward from a point where the lamp barely glows to the point where it ceases to show red. A little practice soon enables one to make adjustments quickly for any of the usual tests made in repair shops. A good size of wire for the winding *s* is No. 4 B. & S. gauge, and the primary winding may be graded from No. 14 up to No. 18.

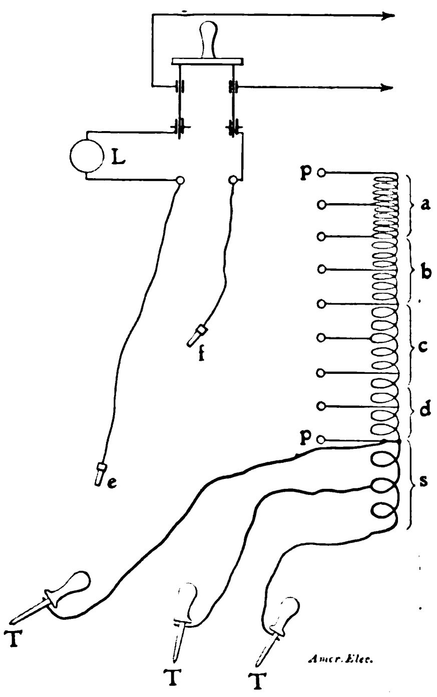

FIG. 1.—MODIFIED TRANSFORMER METHOD FOR TESTING DEFECTIVE ARMATURES.

The other diagram enclosed (Fig. 2) represents a broken two-wire circuit, such as that of a telephone line. The break, *B*, is supposed to have grounded both wires, and the problem is to find out by testing what is the distance of the break from the home end, *A*, of the line. The resistance per foot or mile of the line wire is, of course, known, but nothing else is. Can the break be located roughly under these conditions by a test or series of tests made at the home office at *A*?

A. ELLISON.

New York.

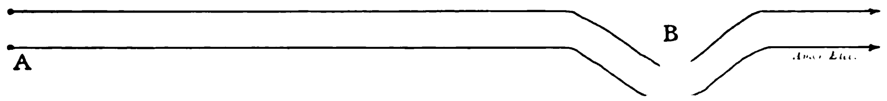

FIG. 2.—BROKEN TWO-WIRE CIRCUIT.

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* This connection is not essential.—ED.

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

What changes are necessary in order to reverse the direction of rotation of an alternator? G. P. O.

If the machine has a rectifying commutator, transpose the cables leading to the brushes of this commutator. The only other change necessary is to turn all the brushes around so that they trail in the opposite direction.

What is the formula for the indicated horse-power of a gas engine? A. L. H.

The formula is

$$\frac{LEAP}{33{,}000} = H.P.,$$

in which L is the length of stroke in feet, E is the number of explosions or ignitions per minute, A is the piston area in square inches, and P is the mean effective pressure. The value of P cannot be calculated with any approximation to accuracy; it must be taken from an indicator diagram.

Can I cut out a damaged armature coil in a revolving field three-phase alternator, or should the coil be taken entirely out of the slots? (2) Can a damaged field coil be short-circuited or should it be removed in order to continue running? J. A. A.

The damaged coil may be disconnected from the armature circuit and its place bridged over with a piece of wire. The safest plan, however, is to remove the coil entirely, as the e.m.f. induced in it may damage it still further and extend the damage to neighboring coils. (2) The field coil may be simply short-circuited and left on the pole in order to maintain the mechanical balance until a perfect coil is substituted.

If an alternating-current circuit contains self-induction, part of the current flowing in the circuit is referred to as "wattless." If the wattless current be multiplied by the voltage, the result should therefore be wattless watts, which is a contradictory term. What would be the correct term? M. O.

The expression "wattless current" is used merely to save time, the correct expression being "wattless component of the current." Similarly, this value multiplied by the e.m.f. of the circuit would give the wattless component of the apparent power in the circuit. No definite name has been generally adopted to apply to this, some engineers using the term "wattless power," others "idle watts," and still others "useless watts." The last term is obviously more nearly accurate than the others.

Is it good practice to start a rotary converter on the direct-current side and close the switches on the alternating-current side without making sure that the machine is in step with the alternating-current circuit? (2) What effect upon the speed relations of the generator and rotary converter would result from changing the converter connections from three phases to six phases? (3) Why are separate lines run for each rotary converter in a system? R. F. T.

This is almost the worst method that could be practiced. (2) There will be no effect upon the speed relations; the speed of a rotary converter is equal to twice the frequency in complete cycles divided by the number of poles, regardless of the number of phases. (3) When this is done, it is in order to reduce the interference between different converters and to avoid disturbance by the converters of the other circuits of the system.

In connecting a two-phase alternator to a three-wire circuit, does it make any difference which two wires of the different phases are connected to the common-return circuit wire? (2) Will the common-return wire need to be larger than the others, and if so, how much? (3) Does this connection increase the voltage, and if so, can it be reduced to normal by reducing the excitation without changing the speed? L. E. T.

No. (2) The common-return should have one and a half times the cross-sectional area of each of the other wires. (3) The e.m.f. across the two individual phase wires will be 1.4 times the e.m.f. of each phase, but the e.m.f. from each of the individual phase wires to the common-return will be equal to the rated e.m.f. of the machine. There is no necessity to change the e.m.f., but if it is desired to reduce the e.m.f. between the individual phase wires to the rated e.m.f. of the machine this may be done by changing the excitation, but the operation of the alternator will not be satisfactory.

What is the difference between synchronous and induction motors? P. W.

A synchronous motor has its field excited from some direct-current source, while its armature takes current from the alternating-current line. The field of an induction motor is supplied from the alternating-current circuit and its armature is not connected to any source of current, the currents in it being induced by the field; hence its name. Furthermore, a synchronous motor having a certain number of poles and being supplied with current from an alternator having the same number of poles will run at the same speed as the alternator regardless of the voltage or load; hence its name, "synchronous." On the other hand, an induction motor also tending to run in synchronism with the generator which supplies it with current, cannot do so, but lags behind the generator by a small amount, the actual lag, or slip, as it is termed, varying with the load on the motor.

What is the effect of shortening the pitch of a lap armature winding on a multipolar machine? (2) How can the connections of the field windings of a multipolar machine be verified without dismantling the machine when the relation between the two leads of each coil cannot be determined? (3) Is there any loss of current when a circuit otherwise thoroughly insulated is grounded at one point? Is not the result about the same as connecting one side of the line to the ground through a condenser or reactance coil? V. E. H.

If the pitch originally was identical with or smaller than the pole pitch, shortening it will decrease the e.m.f. of a dynamo and increase the speed of a motor. If the original pitch was greater than the pole pitch, shortening it will increase the e.m.f. of a dynamo and decrease the speed of a motor up to the point where the two pitches are equal. If the armature coil pitch is very much smaller than the pole pitch, sparking is likely to result. (2) Test the polarity of the pole faces by means of a compass. (3) There would be no loss if absolute insulation were possible; on a low-voltage circuit the loss would be practically negligible. The condition is very different from that of an alternating-current connected to the ground through a reactance coil or condenser.

Can a cluster of 16-c.p. 110-volt lamps be wired without individual fuses? (2) How many lamps can be connected to a branch circuit protected by a fuse plug marked 10? (3) Can a feeder be supplied from either end of a pair of bus-bars? (4) Adjustment of a field rheostat has no effect on the voltmeter connected to the dynamo; what is the trouble? (5) How can a ground in a field-magnet coil be noticed? A. S.

Yes; provided the current required by the cluster does not exceed 6 amperes; a double-pole fuse-block will be necessary for the complete cluster. (2) About 18 lamps, the figures on the fuse plug indicating its rating in amperes. The lamps will have to be divided into two groups, each protected by an individual fuse block and the division being such that neither of the two groups will require more than 6 amperes. (3) Yes. (4) Either the rheostat is badly short-circuited or the voltmeter is out of order. (5) If there is only one ground the insulation test described in the Lessons Department of the November, 1903, issue of this paper may be used. If there are two grounds, so that a part of the field winding is short-circuited, the short-circuited part will be cold and the remainder of the winding will run hot.

What law does the rise in pressure due to compression in a gas engine cylinder follow? (2) How is the rise in temperature due to compression related to the rise in pressure due to the same cause? (3) What is the usual pressure of compression employed in modern gas engines? (4) Why is expansion not carried nearer to the atmospheric pressure before exhaust? D. L. P.

Representing the total volume of the cylinder and compression space by V, the volume of the compression space alone by v, the absolute pressure at the beginning of the compression stroke by p, and the absolute pressure when compression is completed by P,

$$\left(\frac{V}{v}\right)^x = \frac{P}{p}.$$

The value of the exponent x varies under different conditions, but is usually between 1.3 and 1.4. (2) Representing the initial absolute temperature by t, and the absolute temperature when compression is completed by T, the following formula applies:

$$\left(\frac{V}{v}\right)^{x-1} = \frac{T}{t}.$$

Consequently,

$$\left(\frac{P}{p}\right)^k = \frac{T}{t},$$

in which formula the exponent k is equal to $\frac{x-1}{x}$. (3) This ranges from 75 pounds to 200 pounds, according to the design. (4) Because the expansion curve is so flat during the latter part of the stroke that the cylinder would have to be made impractically long in order to expand down to a terminal pressure anywhere near that of the atmosphere, unless the expansion stroke could be made considerably longer than the compression stroke.

WESTINGHOUSE TURBINES OF LARGE OUTPUT.

The accompanying engraving illustrates the type of turbine which will hereafter be built by the Westinghouse Machine Company for large outputs. The machine illustrated is of 5000 kilowatts normal output. The principle of construction is, of course, the same as that characteristic of the smaller turbines, which have several times been described. The chief difference between the machine here shown and the type of machine hitherto built for large outputs is that the entire working parts of the turbine are contained in a single chamber or housing, whereas heretofore the smaller vane wheels have been encased in a housing separate from that which enclosed the largest ones, the two housings being connected, of course, by piping and a shaft bearing located between them. The saving in space by consolidating the working chambers is considerable. The space occupied by the turbine proper of the 5000-kw. set is 27 ft. 8 ins. from the center of the bearing between the turbine and the generator to the extreme end of the turbine shaft, 13 ft. 3 ins. width of base, and 12 ft. in height up to the top of the hand railing. The over-all length of the complete unit is 47 ft. 4 ins. Fig. 2 gives an interesting comparison of the floor space occupied by two 5000-kw. compound reciprocating engines and generators of the type used in the Manhattan Railway power house and four 5000-kw. turbine generator sets of the new type under discussion. A walk-way of 6 ft. is allowed between the two reciprocating engine outfits, while walk-ways 9 ft. 6 ins. wide are allowed between each two turbine generator sets.

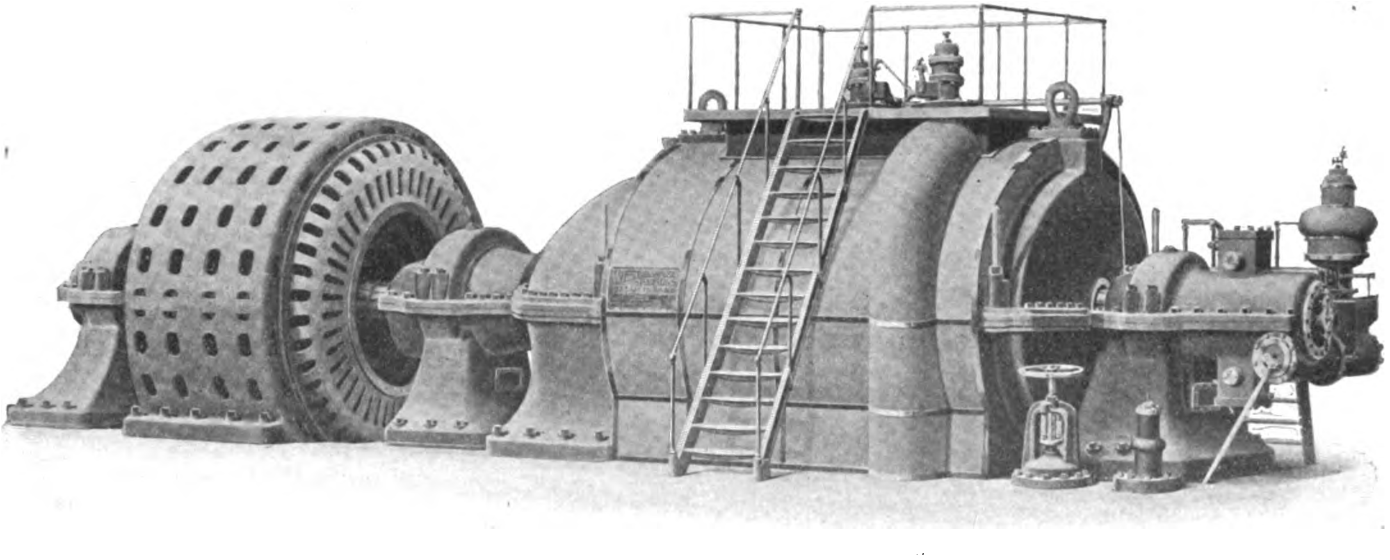
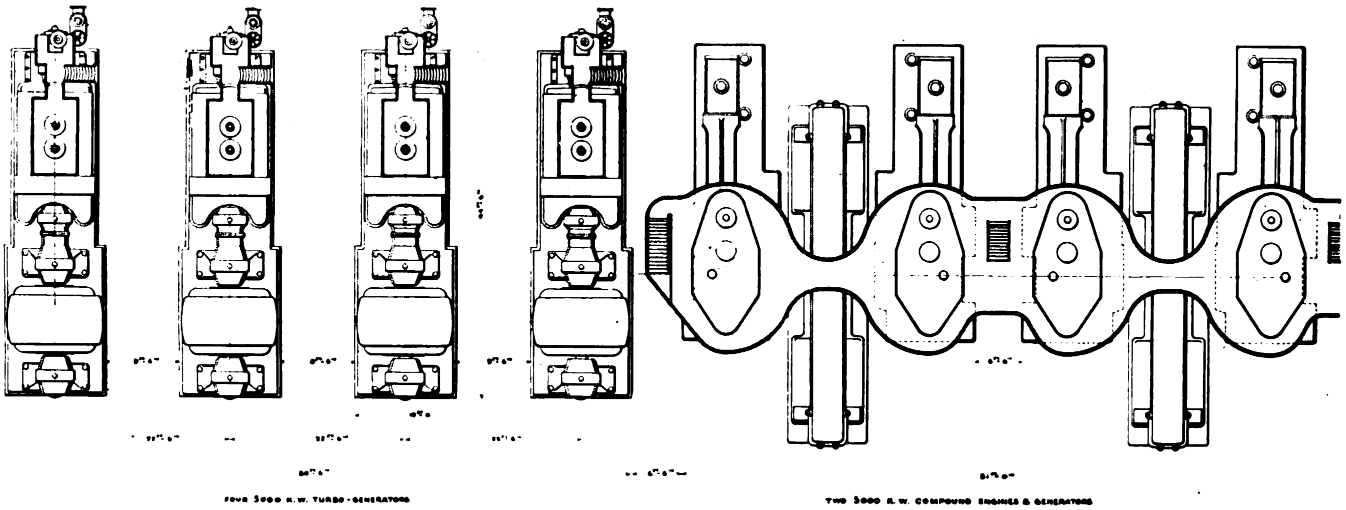


FIG. 1.—WESTINGHOUSE 5000-KW. TURBO-GENERATOR SET.


FOUR 5000 K.W. TURBO-GENERATORS
TWO 5000 K.W. COMPOUND ENGINES & GENERATORS
SAME AS IN MANHATTAN POWER HOUSE
FIG. 2.—COMPARATIVE SPACE OCCUPIED BY 5000-KW. TURBO-GENERATORS AND RECIPROCATING ENGINE-DRIVEN SETS OF THE SAME OUTPUT EACH.

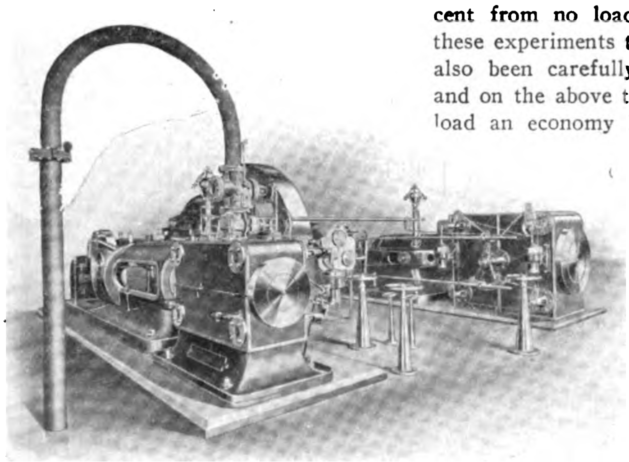
The new type of large turbine shows relatively moderate speeds. The 5000-kw. unit will run at 750 r.p.m., the 2000-kw. unit at 1200 to 1500 r.p.m. according to the frequency desired, and the 1000-kw. unit from 1500 to 1800 r.p.m. according to the frequency. There are several interesting details of construction embodied in the new turbine. The bed-plate, for example, is cast in two sections, and the two sections are held together by links shrunk into recesses in the same manner that some types of sectional flywheels are held together. The barrel or housing is similarly cast in two sections, and these are united by shrunk links; the right-hand half, as the unit appears in the engraving, carries the out-board bearing and governor worm casing, and the left-hand section carries the middle journal and has the exhaust outlet cored into it. As in previous types, linear expansion and contraction are provided for by bolting the journal pedestal between the turbine and the generator solidly to the bed-plate and mounting the out-board pedestal in parallel machined ways so that it is free to slide parallel with the shaft. The main body of the housing is heavily lagged with non-conducting material, which in turn is covered by a sheet-steel casing. Leakage of air from the atmosphere into the exhaust spaces of the casing, where the shaft passes through, is prevented by water-sealed frictionless packing glands. No oil is used, so that the condensation from the turbine is pure water.

The vane-wheels and balance pistons of the turbine are mounted on a central steel quill, into the ends of which hollow forged-steel shaft ends are forced by hydraulic pressure; these are screwed in place by arrow-head links shrunk in. High-pressure steam is delivered to all parts of the quill so as to eliminate stresses and consequent distortion due to superheated steam.

On account of the lower speeds at which the large sets are operated, the "floating" or "nested" journal sleeves used in the smaller turbines are not required; the journals are of the ordinary solid self-aligning type similar to that employed in the construction of generators and reciprocating engines. The diameter of the shaft in the journal of a 5000-kw. unit is only 15 ins.

Steam is delivered to the turbine through an automatic quick-closing throttle valve, a hand throttle valve, a separator, and lastly, the main admission valve under the control of the governor. An important feature of the steam distribution consists of an automatic by-pass valve which admits high-pressure steam to the second stage of the turbine when the unit is overloaded. This valve is controlled by the governor in exactly the same way that the main admission valve is controlled, and grades the admission of high-pressure steam to the second stage according to the requirements of the overload. Within the normal load range of the unit, the by-pass valve remains closed. The use of this automatic by-pass valve results in a rise in the economy curve of the engine under heavy overloads. Like the admission valve, it is of the double-beat poppet type, operated by a small steam piston which is controlled by a pilot valve under the control of the governor.

At the extreme end of the out-board pedestal is mounted an auxiliary speed-limit governor of the centrifugal type, which is set to release a small plunger valve when the speed of the turbine reaches a certain rate in excess of the normal, and this plunger valve controls the quick-closing throttle valve already mentioned. The throttle valve is normally held open by means of an overbalanced differential piston, and when a predetermined excessive speed is attained, from any cause whatever, the auxiliary governor operates the small plunger valve so as to remove the excess of pressure on the differential piston and allow it to close the throttle valve instantaneously. The action of this automatic stop was illustrated several times in an interesting manner during a recent test of a smaller turbine generator unit. The stop was set for 10 per cent excess in speed, and the governor lever was held down so as to leave the turbine uncontrolled; the instant the speed reached the 10 per cent limit the auxiliary governor caused the quick-closing throttle to shut off the supply of steam.



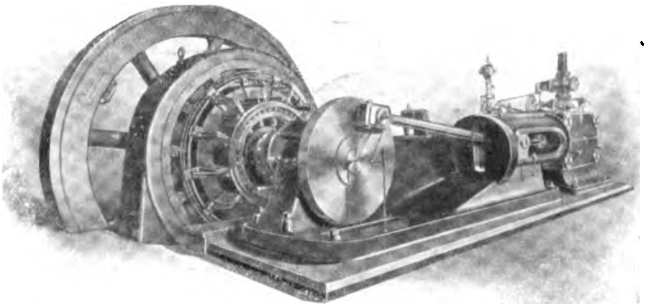


FIG. I.—MURRAY CROSS-COMPOUND AND SIMPLE DIRECT-CONNECTED CORLISS ENGINES OF THE ROLLING MILL TYPE.—FIG. 2.

FAIRBANKS-MORSE GAS ENGINE AND DYNAMO

Fairbanks, Morse & Co., Chicago, have been carrying on a series of tests and making experiments with a line of gas and oil engines specially designed and constructed for electric light work, and the result has been the bringing out of an engine fitted with a special type of governor acting upon air and gas valves and regulating the supply of mixture admitted to the cylinder. It is stated that this governor is so sensitive that with two-cylinder vertical construction regulation has been secured within one per cent from no load to full load. During these experiments the item of economy has also been carefully considered, of course, and on the above type of engine under full load an economy has been secured of ¼ cent per horse-power-hour with gas costing 50 cents per thousand cubic feet; this is natural gas having about 1000 B. T. U. per cubic foot. The close regulation of the engine permits of direct connection to a dynamo; such an outfit is illustrated herewith. Fairbanks, Morse & Co., also being builders of electrical machinery, have special advantages in the matter of designing and proportioning the generator for direct driving by the engine. The construction of these engines is said to be so simple that they can be handled by anyone of ordinary intelligence, not requiring a specially skilled engineer. The Fairbanks-Morse engines can be operated on gas, gasoline, kerosene, crude oil or distillate.

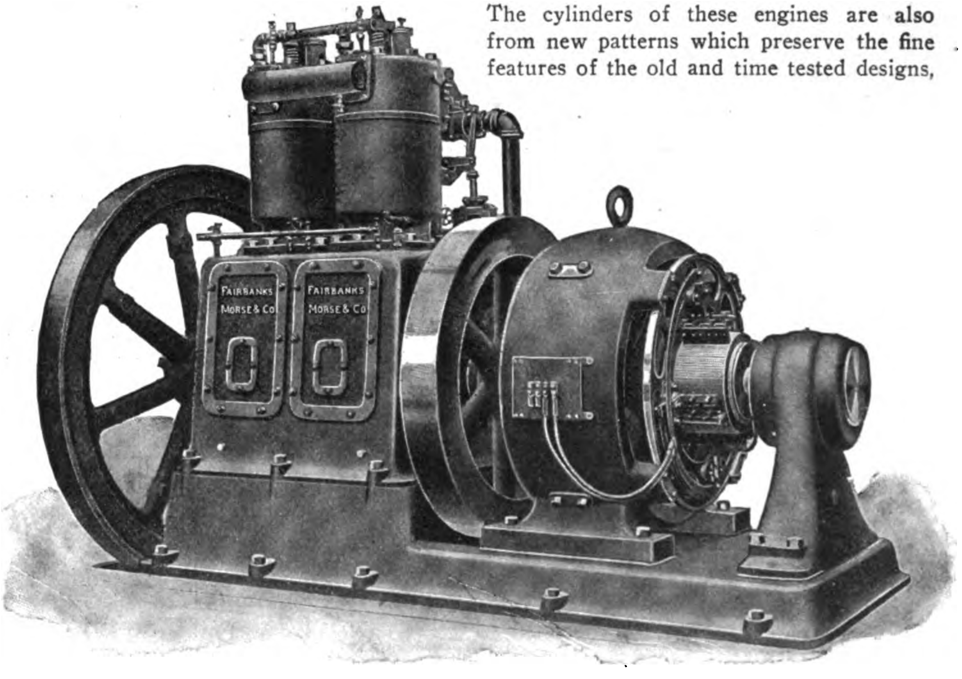


FIG. I.—FAIRBANKS-MORSE DIRECT-CONNECTED GENERATOR SET.

◆

MURRAY "ROLLING MILL TYPE" ENGINES

The Murray Iron Works Company has been developing a new type of engine during the past two years and a number are already in successful operation in as widely separated parts of the country as New York and California, Minnesota and Texas. It terms this new design the "Rolling Mill Type," but it is unnecessary to point out that it is particularly and especially adapted for severe electrical service. The frames of these engines are cast in one piece, and they have lines of beauty and great strength.

The patterns for the right and left-hand styles are entirely separate. Those who know how much is usually sacrificed in the effort to save one set of patterns by making the right do for the left and the left for the right, will appreciate this point. The cylinders of these engines are also from new patterns which preserve the fine features of the old and time tested designs, while adding those required by modern conditions of pressure and speed.

The illustrations herewith show a simple direct connected Corliss engine and a cross-compound unit of the same type.

New Apparatus and Appliances

JUNIOR MIDGET PLUG AND RECEPTACLE.

The accompanying illustration shows a new device brought out by the Marshall-Sanders Company, of Boston, Mass., which they designate the "Junior" midget plug and receptacle. This is similar in many respects to the No. 521 midget plug and receptacle made by the same company, but instead of having a metal lid or hinge to close over the contacts, the connection is made through two insulated holes in the plate. The device can be used in nearly all places where a temporary connection is required with the the exception of floors.

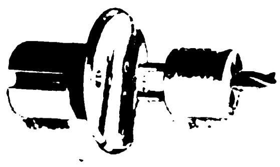


FIG. 1.—MIDGET RECEPTACLE AND PLUG.

THE MORSE THERMO GAUGE.

We illustrate herewith a highly interesting apparatus for gauging the temperature to which steel is heated in the process of hardening or annealing. The principle of the apparatus is shown diagrammatically in Fig. 3. A tube, *T*, contains an incandescent lamp, *L*, having its filament arranged in spiral form, as shown in the end view. At *G* is indicated a source of electric current, at *R* a rheostat and at *A* a voltmeter or ammeter. By means of the rheostat any desired current may be switched on the lamp, giving any desired degree of incandescence, and by noting the current consumption on the ammeter the same degree of incandescence may be obtained at all times.

The instrument is used by simply looking through it at the piece of steel being heated, at the lead bath or into the furnace in which the steel is to be heated, the spiral being, in effect, superposed upon the object looked at. Should the filament be at the higher temperature, it will appear as a bright spiral, while should it be at a lower temperature it will appear as a relatively dark spiral, but, when the two temperatures are the same, the filament will apparently merge into the object looked at and disappear. The temperature at which the best results are obtained in any given case may be fixed for future use by regulating the current to bring the filament to the same temperature which may then be repeated at any future time, or a given temperature in degrees may be obtained by suitable graduations of the ammeter. Fig. 2 shows the instrument as arranged for the direct inspection of tools when heated in a blacksmith's fire. The end of the tube is covered by a hood, to exclude all outside sources of light, the hood having an opening on one side into which the tool is inserted. The accuracy of the indications claimed for the instrument is remarkable. Used in the ordinary way, a variation in temperature of 5° Fahr. either side of that of the filament may be detected, while, by using a magnifying glass, this is reduced to a single degree.

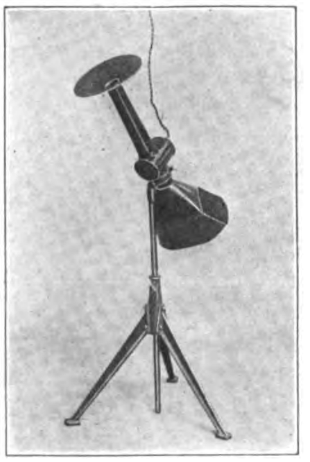


FIG. 2.—MORSE THERMO GAUGE.

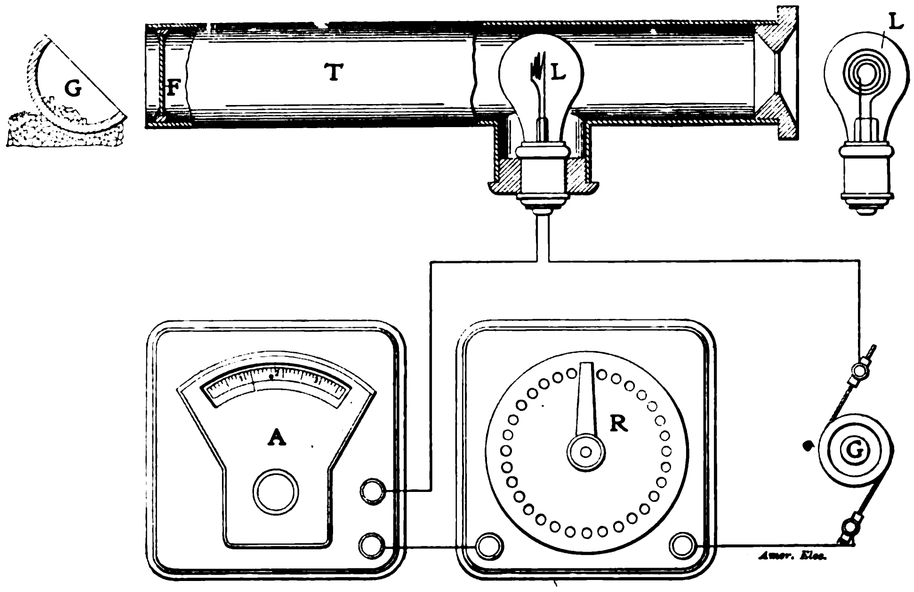


FIG. 3.—MORSE THERMO GAUGE.

Anyone acquainted with the gradual deterioration of the filaments of ordinary incandescent lamps will naturally ask if these filaments do not deteriorate in the same way and thus vitiate the results. This is not found to be the case, for the reason that the temperature at which steel is hardened is much lower than that to which an ordinary incandescent lamp filament is subjected. The latter is a glowing white heat, while the former is a "cherry red" or lower. At these latter temperatures the filaments are not found to deteriorate appreciably, one of them having been in constant use for the past three years. Moreover, the readings of the ammeter are in all cases standardized, in order that different instruments may give the same results. The graduations may be made to indicate the degrees of temperature directly or they may be arbitrary marks for different brands of steel and different classes of work. The instrument is made by the Morse Thermo Gage Company, of Trumansburg, N. Y.

SMALL STEEL FRAME ELECTRIC MOTORS.

The Triumph Electric Company, of Cincinnati, Ohio, has just brought out a new line of small steel frame bipolar machines ranging in size from one-half to five horsepower. The crown and pole pieces are made of soft, close-grained steel, the latter being fitted and bolted to the crown. Cast iron yokes are centered against the sides of the crown and are held in position by bolts. These yokes can easily be rotated so that the machine may be used on a wall or ceiling. The bearings are of the self-oiling gun metal type, and are interchangeable. Fig. 4 herewith shows the frame, armature poles and field coils of a one-half horsepower motor. The armature core is built up of thin sheet steel disks mounted on a hammered steel shaft. These disks are notched and after punching are annealed and varnished before being assembled on the shaft. The field coils are form wound and thoroughly insulated. After being baked they are tested with alternating current before being placed on the poles. The

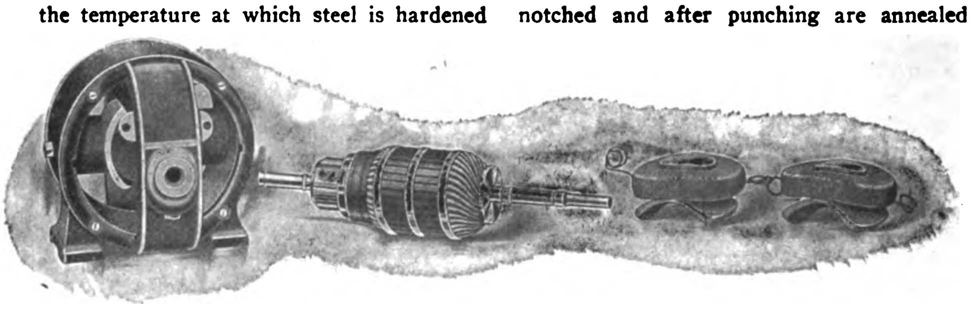


FIG. 4.—TRIUMPH MOTOR FRAME, ARMATURE, POLES AND FIELD COILS.

brush holders are of very simple design. Carbon brushes are used, and these are fastened rigidly at the end of the holder, which is clamped to the stud, and is provided with a simple and ready means for adjustment. As there is no sliding friction of the brush in the holder, the spring has but little weight to move, so that the tension is very light. A quick and sensitive adjustment of the brush is said to be the result whereby sparking and heating and wearing of the commutator are claimed to be eliminated. The efficiencies at full load range from 72 per cent in the half horse-power motor size to 87 per cent in the five horse-power machine. The one-half and three-quarter load efficiencies range correspondingly from 67 per cent and 71 per cent to 83 per cent and 87 per cent.

NEW VOLTAGE REGULATORS.

Recently the General Electric Company has placed on the market two new types of voltage regulators which admirably suit the conditions for which they were designed, They are known as Type TD and Type TA. Type TD regulators (Fig. 5) are designed for use in connection with direct-current generators only, while Type TA (Fig. 6) though primarily designed for use with alternating-current generators, may, if provided with an exciter, be used with direct-current generators as well. These instruments operate on the principle of rapidly opening and closing a shunt circuit across dynamo field rheostat terminals, the rheostat having considerable resistance turned in to give the regulator a good margin to work on. Type TD regulators are arranged to open and close a shunt-circuit across the generator field rheostat; Type TA controls a shunt across the exciter field rheostat.

The direct-current regulator, Type TD, contains a relay and a secondary magnet. The magnet is differentially wound, one of these windings being permanently connected to the work circuit, while the other is opened and closed by contacts which are operated by the relay. As the relay contacts are opened and closed, they simultaneously open and close the secondary magnet contacts by means of the differential winding of the magnet; these contacts open and close the shunt circuit across the generator field rheostat. To prevent injurious sparking at the magnet contacts, condensers are connected in multiple across them. This regulator will maintain constant voltage on one shunt wound generator, or will maintain constant voltage on several compound wound generators operating in parallel, regulating, however, only one at a time. Several generators can be arranged to be controlled by one regulator, by means of a five-point rotary switch, as shown in Fig. 5. The generator which is regulated has a tendency to take the sudden fluctuations of load, but these are equalized between the several generators by means of the compound windings of the machines. With shunt-wound generators it is necessary to have a regulator for each generator to be regulated. These regulators are usually arranged to maintain constant voltage at the bus-bars, but may be connected to pressure wires brought back from the centre of distribution, thus maintaining constant voltage at the centre of distribution.

The Type TA regulator is designed to maintain a steady (but not a constant) exciter voltage, and consists of the same direct-current relay and differential magnet as the Type TD with the addition of an alternating-current control magnet having a potential and an adjustable compensating winding. These two windings work in opposition to each other. This magnet operates the lower main contact. The magnet core and lever are arranged by means of a counterweight to come to a balance at the correct voltage. Should the alternating voltage vary, it would change the position of the lower main contact, which would cause the exciter voltage either to be raised or lowered and restore the normal voltage. Without the use of the compensating winding, the regulator will maintain a constant bus-bar voltage, and by the use of the adjustable compensating winding and current transformer in the circuit to be regulated, the regulator will automatically compensate for line losses. The alternating voltage is automatically kept at its desired value by varying the exciter voltage. Once the regulator is adjusted to maintain constant voltage at the centre of distribution it requires no further adjustment and the station voltage will be automatically increased or decreased with the load to maintain the desired voltage at the centre of distribution. This regulator is independent of temperature and frequency changes.

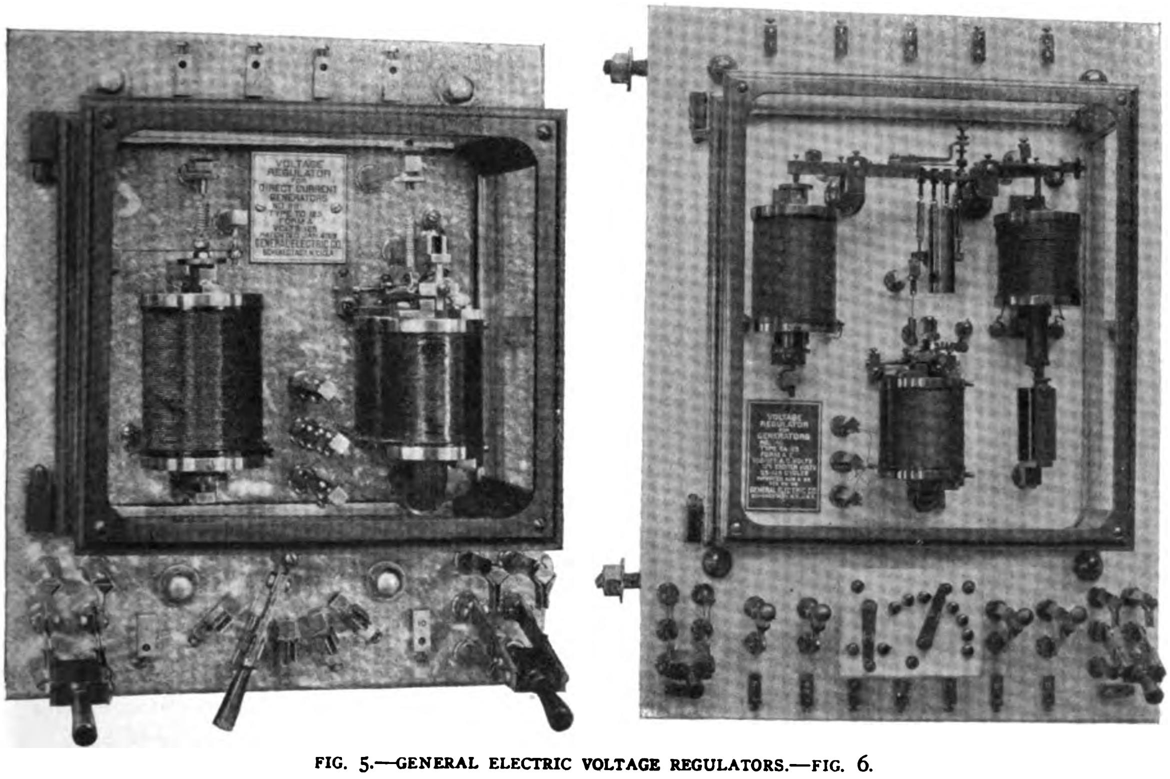


FIG. 5.—GENERAL ELECTRIC VOLTAGE REGULATORS.—FIG. 6.

SMALL STANDARD SWITCHBOARDS.

The W. S. Hill Electric Company, of New Bedford, Mass., has brought out and placed on the market a line of small standard switchboards having capacities of 50, 75, 100 and 200 amperes, designed to control the output of a single generator having an output not exceeding 40 kilowatts. Each board has six circuit switches of various sizes to meet any ordinary requirements, and these are designed to take standard enclosed fuses. The panel is made of black Monson slate and everything possible, it is claimed, has been done to make a board which will conform to the Underwriters' requirements and yet be inexpensive. The boards are equipped with the well-known Weston,

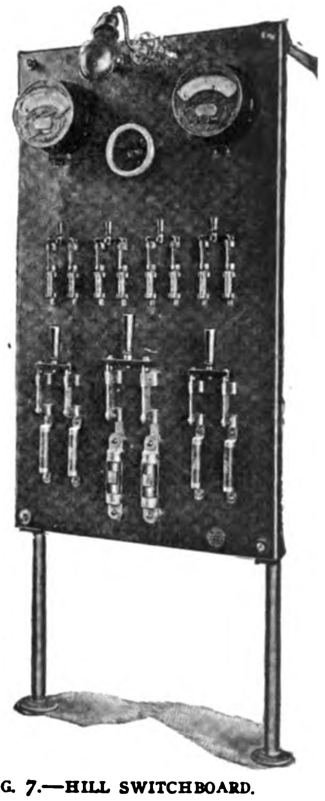


FIG. 7.—HILL SWITCHBOARD.

round pattern, type F instruments and switches made by the Hill company. Fig. 7 herewith shows a complete board.

HIGH POTENTIAL OIL SWITCHES.

The increasing use of high potentials has presented many serious and unusual problems in switching and the protection of the generating apparatus from dangerous overloads. The oil break type, in which the switches and all live metal parts are immersed in oil, is generally conceded to be the best form of switch for handling high voltages, and the most recent development of this type, designed by the Hartman Circuit Breaker Company, of Mansfield, Ohio, is shown in the accompanying illustration.

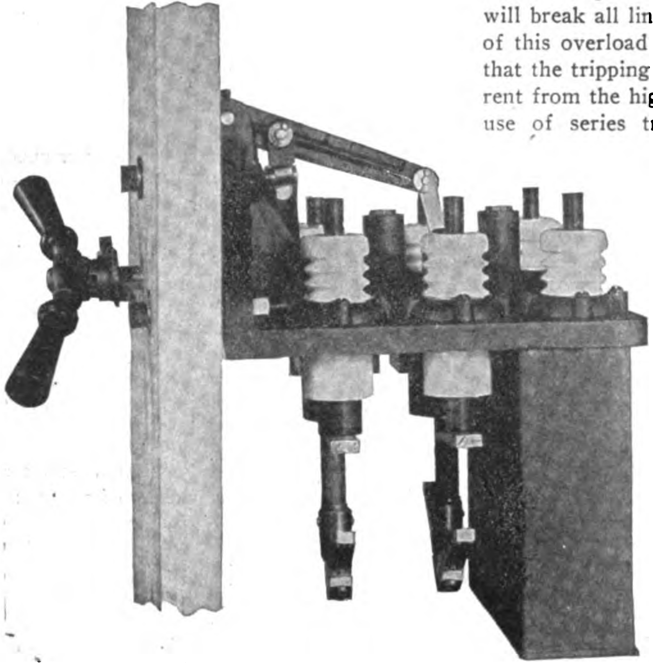


FIG. 8.—HIGH POTENTIAL OIL SWITCH.

Fig. 8 is a view of a three-pole, double-break oil switch designed for installing on the back of the panel, and to be used on circuits up to 11,000 volts. The view shows the switches in the "off" position, with one of the switches enclosed in an oil tank. Each pole of the switch is immersed in a separate tank, which is entirely independent of the adjacent ones and can be readily removed without in any way interfering with the others. The tanks are lined with insulating material formed in such a way that there is just sufficient space for the free vertical movement of the switches, and the quantity of oil used is thus reduced to the minimum. A distinct departure in this oil switch is found in the use of the laminated or brush form of contact, which it is said greatly increases the current-carrying efficiency of the switch and also prevents "freezing" or sticking at critical periods. These contacts are protected by final arcing plates, which, with the corresponding plates on the terminal blocks are removable and can be readily replaced should they become burnt away in the course of time. The form of contact which is used and the isolation of the switches in separate compartments, give the switch a very large breaking capacity. The movable parts of the switch are controlled by means of specially treated wooden rods, which are fastened at their upper ends to a common cross-bar. They are held in normal position by means of a toggle lock. The switch is opened by giving the handle a slight turn in the proper direction. This will cause the toggle to move past the center and the switches will then open free of the controlling handle. Another form of switch is made with automatic overload attachment. There are usually two tripping coils provided for a three-pole breaker, but it can be constructed with a tripping coil in each line. In all cases the operation of any one tripping coil will break all lines. The distinctive feature of this overload attachment lies in the fact that the tripping coils are energized by current from the high potential circuit, and the use of series transformers in connection with the circuit breaker is entirely avoided. The tripping coils instead of being located on the front of the panel are mounted by means of special porcelain insulators on the carrying frame itself. They are separated from each other by barriers of insulating material. The overload attachment has other distinctive features, one of the most important of which is that it cannot be held closed while an overload exists on any line. This apparatus is also constructed with remote electrical control, the operating current being obtained from any convenient source f direct current supply at from 110 to 500 volts. The remote control attachment is said to be very reliable.

IDEAL ELECTRIC MOTORS.

Fig. 9 herewith, shows one of a new line of motors brought out by The Ideal Electric & Manufacturing Company, Mansfield, Ohio. This line is known as Type R, and ranges in capacity from 2 to 35 horse-power. The machines are made in three styles—open, semi-enclosed and enclosed—and can be used for belting, coupling or gearing to machines or shaft, and mounted on the wall, floor or ceiling. The armature core discs are of thin gauge, and the armatures are built directly on the shaft. They are provided with ventilating openings parallel to the shaft, through which air may pass to the ventilating ducts between the discs and the outer ribbed flanges. The winding consists of form-wound coils, the smaller armatures being wound with round wire and the larger ones with flat copper strip. Surface bands are used to retain the coils in the slots. Fig. 10 shows the armature of this machine. The commutator segments are said to be of unusual length and depth, allowing an ample margin for wear. The flanges are of cast-iron and are insulated from the segments with solid "V" rings. The brush-holders are clamped on the stems close to the point of brush contact. Composition graphite and carbon brushes are used, which are fed toward the commutator through a milled trough in the face of the holder. A flat phosphor bronze springs holds the brushes firmly against the face plate, and brush tension is provided through a finger actuated by an adjustable spring. The brushes are said to operate without vibration, and the machines, it is claimed, run practically noiseless. The brush-holder stems, to which the holders are fastened, are insulated from the quadrant and firmly secured to prevent them from working loose. The brushes may be readily and independently adjusted, it being possible to quickly remove any brush while the motor is in operation. The brush area is claimed to be ample, the current density being, it is said, very low and at the same time consistent with economical design. This line of machines is designated to operate at full rated capacities without more than a 30° C. rise in the temperature in the armature or field windings. They are claimed to operate at an overload of 25 per cent. for a period of two hours, and to withstand a 50 per cent. overload for two or three minutes without injurious heating or sparking. The company has also placed upon the market a line of elevator and hoisting motors and controllers and a complete line of belted and engine-type generators in sizes up to 150 horse-power.

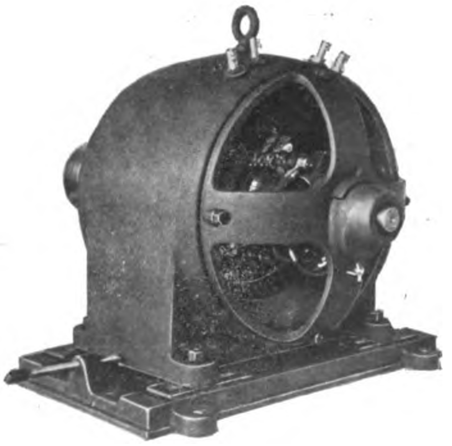


FIG. 9.—IDEAL STANDARD MOTOR.

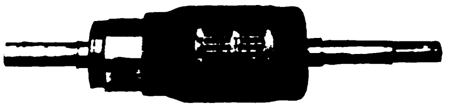


FIG. 10.—ARMATURE OF IDEAL STANDARD MOTOR.

IMPROVED NERNST LAMP.

In the description of the Nernst lamp made by The Improved Electric Light and Supply Company, of New York, which was published in this department last month, it was erroneously stated that the current consumption of the 32-c.p. lamp was in the neighborhood of 100 watts. This should have read 50 watts instead of 100, the latter being the current consumption of the 64-c.p. lamp.

American Electrician.

Vol. XVI. New York, February, 1904. No. 2.

ELECTRIC RAILWAY CONSTRUCTION IN PARIS.

CONDUIT SYSTEM OF THE GENERAL PARISIAN TRAMWAYS COMPANY.

BY FRANCIS PAUL.

An interesting field for the study of electric traction is found in Paris, owing to the fact that the municipal authorities have forbidden the use of the trolley within the city limits, and these conditions have given a good opportunity to test all the known systems of mechanical traction. While the horse omnibus is still to be seen everywhere in the city, most of the principal railways have changed over long ago to mechanical traction. At first steam and compressed air were employed, but nearly all the more recent systems are using electricity. Within the last few years a great number of lines have been installed which use either the surface contact or accumulators. To these must be added the extensive underground conduit system which has been installed by the Compagnie Française Thomson-Houston. It affords a good example of a successful conduit railway, and, in fact, is one of the most important in Europe.

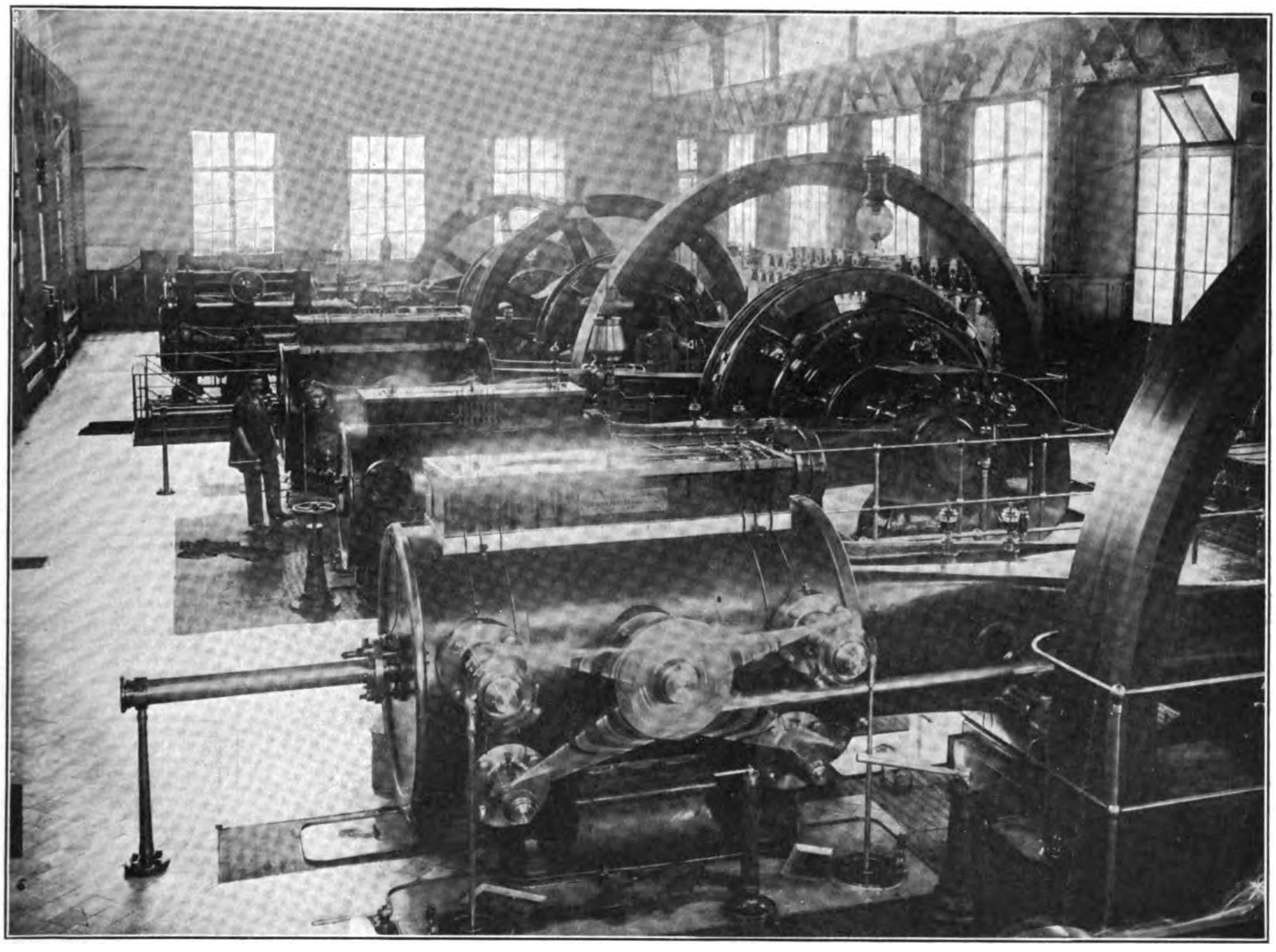


FIG. I.—GENERAL VIEW OF POWER STATION.

The conduit line runs in double track from the Place de la Bastille, located in the eastern part of the city, making a semicircle and ending at the Asnières Gate, to the north, where it joins a short trolley section which runs to the suburb of St. Ouen. The whole system is nearly eight miles long, of which the conduit road forms the greater part. As regards the running of the cars, the conduit line is operated in three distinct sections. The Paris conduit system possesses especial interest due to the extensive scale on which it has been carried out and to the fact that the usual form of central conduit has been replaced by a type of side conduit which has been specially designed to meet the present requirements.

All the preceding lines which have been installed by the same company in Europe, such as the extensive systems of Lyons, Nice and Bordeaux, were laid out on the central conduit system, which somewhat resembles the type of conduit which is used in the United States, upon the lines of the Metropolitan Company, of Washington. It differs from the latter, however, in the fact that the supports of the insulators which hold the contact bars are fixed directly to the base of the conduit rails. The pits in which the insulators are placed are not only covered by a cast iron plate, but also by the paving, which is laid over the manhole covers. This construction suppresses the numerous manholes in the street, conforming to the municipal regulations which have been adopted in many parts of Europe. In Paris, however, it was found impracticable to use the type of central conduit, on account of the wood paving which is used on most of the streets. When the central conduit is laid in the wood pavement, the excessive wear of the latter soon causes the conduit rails to project above the surface and thus form an obstacle to the passage of vehicles. As the ordinary rails of the track are already subject to the same difficulty, it was desired not to increase it still further by using the central conduit. The problem has been happily solved by designing a type of side conduit which will be described somewhat in detail.

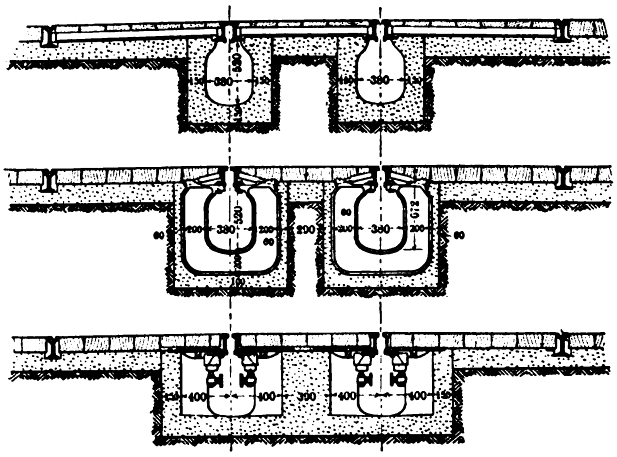


FIG. 2.—SECTIONS OF UNDERGROUND CONDUIT CONSTRUCTION.

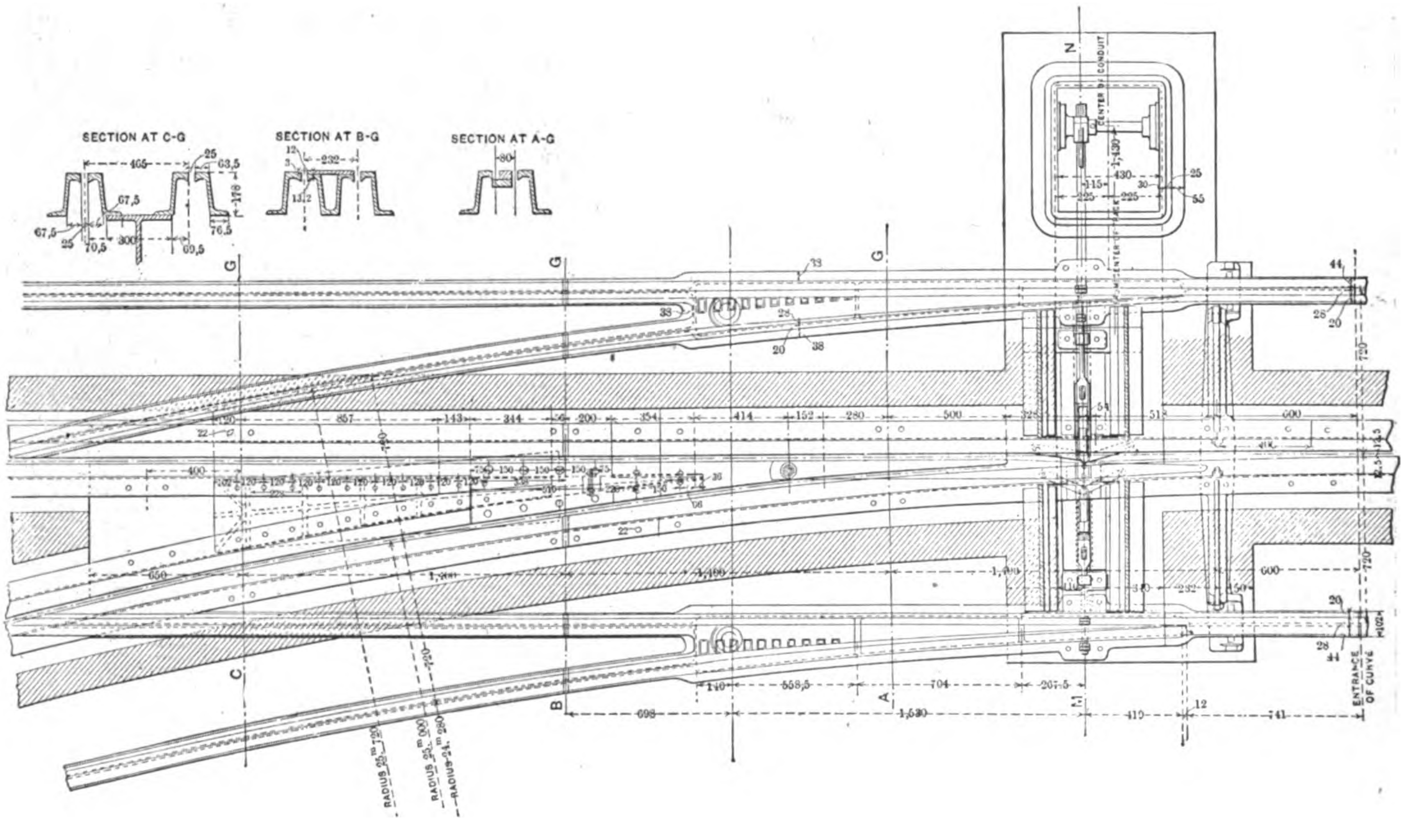


FIG. 3.—SWITCH MECHANISM, WITH SLOT IN CENTER OF TRACK.

The side-conduit system, however, presented a certain number of disadvantages, and means had to be found to overcome these. The following are among its principal drawbacks: First, the obstruction which might occur in the slot of the conduit becomes of double importance owing to the fact that it is now obliged to give passage not only to the contact plow but also to the flanges of the car wheels. Second, the conduit structure is obliged to support the weight and the direct effort of the vehicles. On this account a more solid construction becomes necessary. Third, the insulation of the contact plow becomes more difficult owing to the fact that it receives splashes of mud on its surface, coming from the car wheels. Fourth, it has been found impossible to construct a switch system for the side conduit which gives complete satisfaction.

This last disadvantage is much more important than the others. On the one hand, to take the flanges of the wheels requires the conduit to be made with a large groove, and on the other, the upper surface of the switch should be on a level with the top of the rail and should be solid, while at the same time presenting a considerable width at the points of support. Under these conditions, a switch possessing the necessary mechanical qualities would require a groove measuring from 1.8 to 2 inches at the extremity of the switch point. Such a width might be admissible in some European cities, but it is needless to say that in a city like Paris, where the vehicular traffic is chiefly made up of light vehicles, it could not be employed without occasioning serious difficulties, and it is necessary to avoid it as much as possible. In the present system the question has been solved by using the following method:

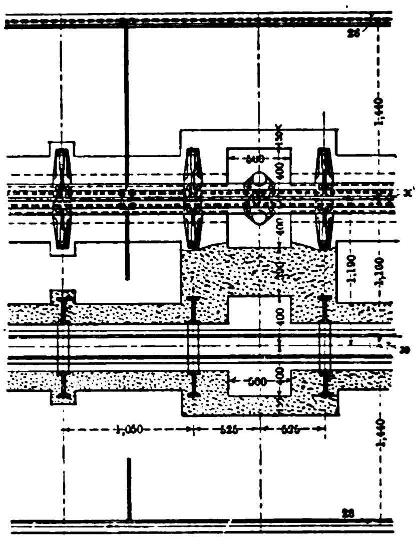


FIG. 4.—PLAN OF UNDERGROUND CONDUIT.

The conduits are placed on the inner side of their respective tracks and are supported by a series of frame castings, which are spaced 42 inches apart. The outer or independent rails of the track are held in place by a series of brace strips, which connect them with the conduit rail and are spaced 84 inches apart. The two conduit rails which lie next each other are braced across by a similar set of wrought iron bars. The general construction will be observed in the sectional view of the track, Fig. 2. The upper section shows the double track with the conduits lying adjacent on the inner side. The large flanged castings are laid in a trench and surrounded by concrete. These castings serve to support the double rail at the top which forms the rolling surface and leaves a sufficient space for passing the conduit plow. The middle section shows the portion of the conduit lying between the supports. It is surrounded by a layer of concrete. The bottom section shows the arrangement of the manhole and cover, and the mounting of the contact rails with their insulators. A plan view of the track is shown in Fig. 4; in the center is the manhole with the insulators for the contact bar, and on either side are the frame castings.

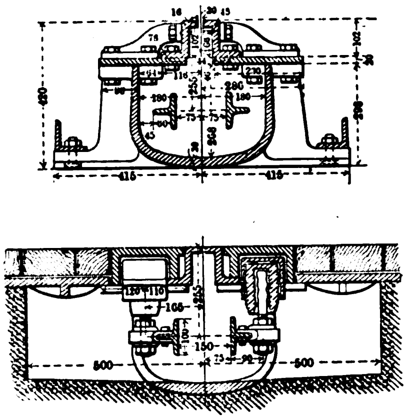


FIG. 5.—SHALLOW CONDUIT.

The conduit system is established by first sinking the frame castings in the roadbed at the proper intervals between the rails of the track. The castings are then connected across to the rails by means of the brace rods and the whole thus forms a solid construction. In the intervals between the frames are placed a series of forms which are made by bending sheet-iron into the form desired for the conduit, and which is defined by the inner opening of the frames. Concrete is then placed around the forms and when dry the latter can be drawn out through the central slot, as they are sufficiently flexible. It only remains to lay the wood paving. This method is simple, and can thus be carried out rapidly. In spite of the different delays which were caused by outside reasons, the Paris conduit was laid at the rate of 375 feet of double track per day. The expansion of the wood paving did not alter the width of the groove, and the conduit was found to resist the highest pressures. As concerns the branch points which occur at the terminals or switching points of the line it was found advisable to pass from the side conduit to the central conduit, as will be observed in Fig. 5. The switch shown to the right is the same as has been used at Lyons, and works very satisfactorily. The plan view and section are shown in Fig. 3. As the opening of the groove at the switch tongue is considerable it is protected by a sliding plate, which moves underneath it. The conduit switch is moved at the same time as the rail switch by a common lever which is placed at the side of the track. The lever is automatically thrown back by the contact plow as it passes.

Where the line crosses the Seine over the Alma Bridge the distance between the masonry arches of the bridge and the street level was found to be too short to allow the regular depth of conduit to be used, and a special form of conduit had to be designed, which would meet the requirements. This type will be observed in the two sectional views of Fig. 5. Here the conduit is made up of sections of a cast-iron tube which are placed together end to end. The sections are about 3 feet long. In the middle the tube is reinforced by a cast web, which forms the base plate for the support. The tube is completed at the top by a cast-steel plate, which is bolted to the upper surface, and serves to support the conduit rails, which have a *Z* section. A series of cast steel brace pieces are bolted to the steel plate and the conduit rail on either side, so as to hold the latter firmly in place. The portion of the conduit which lies within the pit is seen in Fig. 5. Here the casting which forms the tube is open at the sides, leaving only a short strip at the bottom. The method of fixing the insulated supports which hold the conducting rails is shown.

As the use of this type of shallow conduit made it necessary to raise the conducting rails to a higher level, which made a difference in height of five inches above the level of the conductors in the standard conduit on either side, a special device was needed in order to raise and lower the contact plow when the car passed from one type of conduit to the other. This operation had to be carried out independently of that required at the terminals of city line where the plow is to be raised out of the conduit in order to proceed on the trolley section. On two of the less important conduit lines in the United States, the same problem has been solved by simply attaching the contact-plow to its supporting piece or again detaching it when necessary, but for an extensive system such as the one under consideration, where the operation needs to be repeated many times per day, this primitive method would cause a considerable loss of time. It was also desired to avoid the necessity of placing the men in the underground posts, and to perform the operation entirely from above ground.

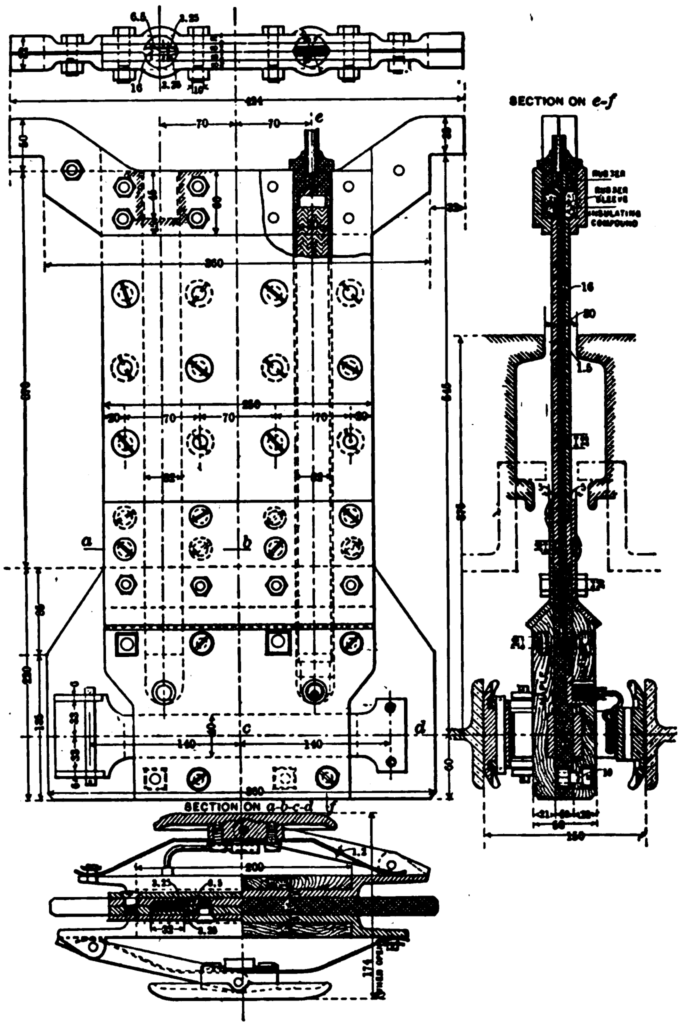


FIG. 6.—SECTIONS AND SIDE ELEVATION OF PLOW.

In Europe this problem has already been studied in connection with some of the leading conduit systems, and has been solved in a very ingenious manner. At Brussels, on the Berlin system, and more recently at Budapest it is recognized that the most simple and practical solution is to maintain the plow underneath the car in all cases, and to devise an apparatus which will allow it to be raised out of the conduit or lowered into it again as required. The types of contact plow which are employed in these cities have been designed so that they can be lifted out through the normal groove of the conduit, and thus can be raised or lowered as may be necessary at any point on the line. In this case, however, the width of groove which has to be adopted becomes considerable, and the design of the contact plow which is used in such cases may be criticized from many standpoints. After a careful study of the subject the contact plow was designed on somewhat the same lines as the form which proved so successful on the Washington conduit system. The plow is provided with two rubbing shoes of cast iron (Fig. 6), which are pressed against the contact rails by light elliptical springs and supported by a pair of horizontal bearing straps which serve to limit their side movement. By the use of these side straps the springs are not required to possess a great mechanical resistance, seeing that the contact shoes are now held by the straps and the latter serve to take up the pressure and the shocks. The springs serve only to secure the slight pressure which is needed between the contact shoe and the bar.

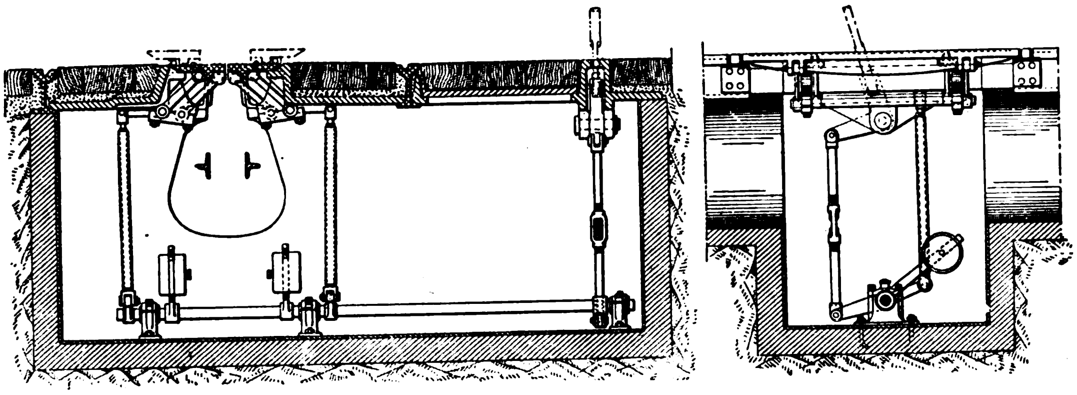


FIG. 7.—ARRANGEMENT FOR WIDENING SLOT TO PERMIT REMOVAL OF PLOW.

In the design of this form of contact plow the constructors introduced some of the principles which have been put in practice by the General Electric Company in order to obtain a great mechanical solidity combined with a sufficient insulation. As will be observed in the engraving, Fig. 6, the plow is built up of sheet iron plates and supports a cross-piece of maple wood and fiber at the lower part which serves to hold the contact shoes. The two wires which pass down between the plates are well insulated from the latter. This type of plow is not intended to be raised out through the slot, as this has not been found necessary in practice.

As to the form of contact plow mentioned, which is designed so as to be raised out of the conduit at any given point, the advantage of such a system is not as great as might be supposed, for in practice it is found sufficient to carry out the raising and lowering operations at the points where the line changes over from the underground to the trolley system or *vice versa*. The operation can, in fact, be easily performed by constructing a passage way for the contact plow at the terminals of the underground system, and adopting a method for rapidly opening and closing this passage by a simple and strong mechanical device. The sectional views, Fig. 7, show the arrangement which was finally adopted for raising and lowering the plow. It was first installed on the Bastille-Charenton line at Paris, which was the first conduit section to be used in the city. As it proved quite satisfactory in its operation, it has now been adopted on the succeeding conduit systems.

At the point where the plow is to be removed, a large underground vault has been constructed. Access to the vault is obtained by a manhole on the right. As shown, the side conduit has now been switched over to a central conduit, and part of the conduit rail has been cut away to leave place for a pair of cast iron trap-doors, which occupy their place. These trap-doors are supported on the outer side by a frame casting, and turn upon a special form of hinge which connects them with the conduit rail. To open up the trap-doors they are raised to the position indicated by the dotted lines by a system of levers which work the hinges and these levers are operated by simply throwing over the lever which is seen on the right, which is provided with a counterweight to balance the weight of the traps and allow one man to raise them easily. On the descent of the contact plow into the conduit it is guided into place by a set of sheet iron pieces.

On arriving at the point for the removal of the plow the motorman operates the traps from above ground by means of the lever, which can be removed from its socket. He then raises or lowers the contact plow by turning a handle at the side of the car, which works the device which will be described. In case of crowded traffic, these operations are performed by a man on the two traps which are placed beside each other for the two tracks. One of the interesting features of the Paris conduit system is the device which is used for raising and lowering the plow. Three different conditions had to be met to suit the needs of the road; first, the plow must be able to travel from one side of the car to the other, taking a lateral movement, so as to pass from the side to the central slot; second, when in its middle position the plow is to be lowered into the conduit or raised out again; third, when the plow is in the side position and working within the conduit, it is to be raised or lowered through a certain distance when it is necessary to pass from the standard conduit to the shallow section, such as is found at the Alma Bridge; fourth; at the proper points the circuits are to be changed over from conduit to trolley, or *vice versa*, by an automatic switching device.

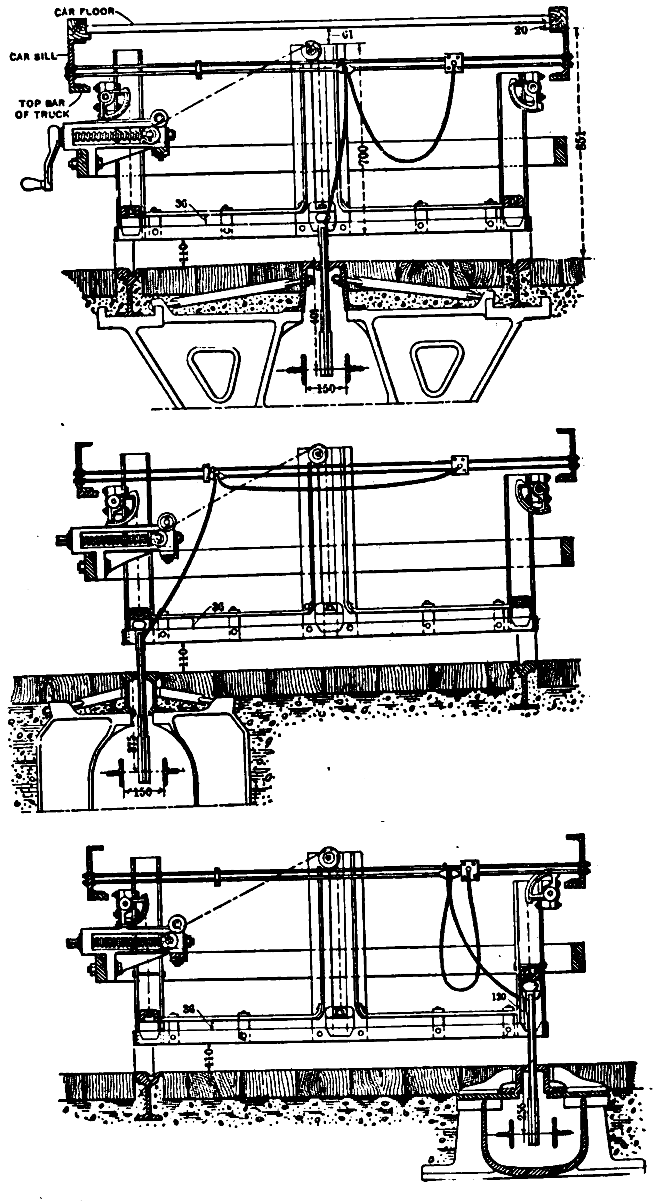


FIG. 8.—SECTIONS SHOWING POSITION OF PLOW IN DIFFERENT TYPES OF CONDUIT.

In Fig. 8 the plow is shown in the three different forms of conduit, from which a general idea of the system may be obtained. The supporting frame of the plow is shown in greater detail in Fig. 9. The plow is raised and lowered by suspension chains which pass around sheaves and are operated from the outside. The device, as a whole, is the same as that used on the first Paris conduit, and on the Lyons and Nice systems, but differs from these as to the method of lifting the plow. On the former lines the lifting chains were attached directly to the plow. This method would not answer in the present system, since the plow is obliged to travel from one side of the frame to the other. The plow is held upon the carrying rails by means of its two upper lugs, as will be noticed in the end view of Fig. 6. Continuous with these rails is a kind of supporting framework, which is placed at the middle (Fig. 9) with a similar one at each end. The lifting chains are fixed to these frames, and when the plow is shifted upon any one of them it can be lifted up, that is, when it occupies the middle or the end position. As will be noticed in the sectional view (Fig. 9), the chains are attached to the frame by means of a lock device, which holds the frame down to the rail. As the chain is tightened, it first unlocks the catch from the rail and then draws up the frame in its vertical guides, and along with it the plow. When the chain is lowered the reverse movement takes place, and the plow comes down into place while the catch is locked in position by a spring.

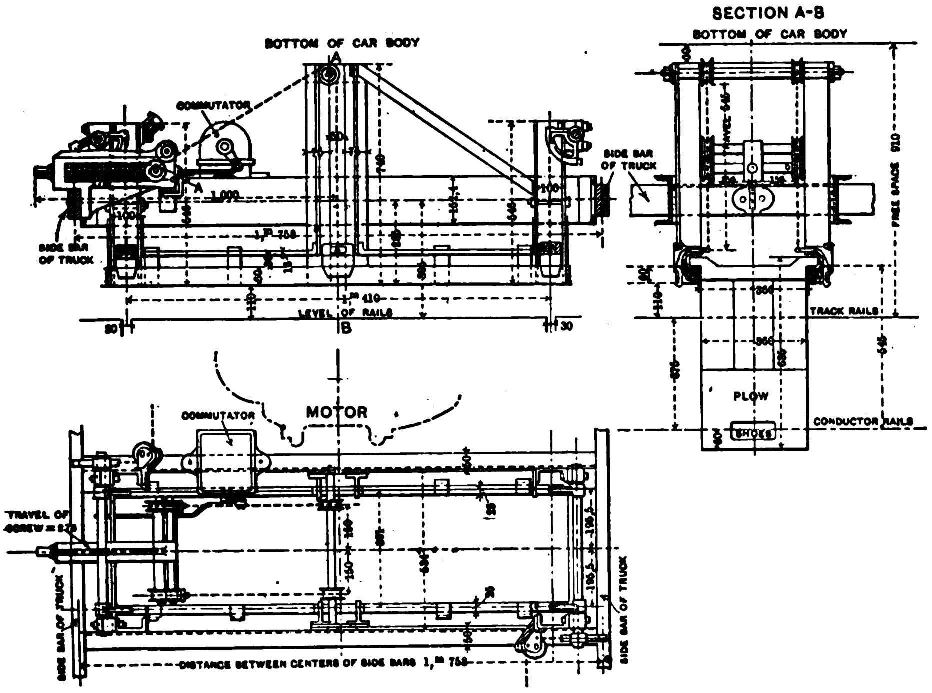


FIG. 9.—METHOD OF SUPPORTING AND RAISING PLOW.

To the left of Fig. 9 will be noticed the device which is used for working the chain. The latter is attached to a traveling carriage which moves back and forth in a guide frame by means of an endless screw. The screw is operated from the side of the car by a removable handle, as will be observed in the upper view of Fig. 8, which shows the plow in the central conduit. At the same time the electrical connections are automatically changed by means of a revolving commutator, which is connected with the screw mechanism by a lever. This commutator is constructed on somewhat the same lines as a controller, having a drum carrying a set of contacts, over which pass the stationary brushes. A quick break is made at the contacts by means of a spring, in order to avoid arcing. The middle section of Fig. 8 shows the method which is used for the side conduit. Here the plow is raised by a chain and sector, which are operated in an analogous manner. The lower section indicates the operation for the shallow conduit, where the plow is to be raised but slightly.

In order to furnish the current needed for this extensive conduit system, a large generating station has been erected towards the western part of the city. The plant is located at a distance of 500 feet from the Seine River, which allows the coal to be brought upon barges. The station occupies a total surface of 28,080 sq. ft., of which 17,180 is covered by the buildings. The station comprises a boiler room, a dynamo room and a very extensive car barn (situated in the vicinity) which is probably the largest in the city.

The boiler room, which is laid out on the ground level, is fitted up with seven multitubular boilers of the Niclausse make, which are disposed so as to form three batteries in all. Each of these boilers presents a heating surface of 1,350 sq. ft. and has a steam producing capacity of 4,000 pounds of steam per hour on the average run, which can be increased to 5,500 at times of heavy loads. The feed water is supplied to the boilers by three pumps. Two of these are steam pumps of the compound type and the third is driven by an electric motor: this latter pump is of the two cylinder pattern. The water for the station is supplied by a well which has been sunk upon the station premises, and delivers about 5,400 cubic feet of water per hour. This is raised from the well by a motor-driven pump which feeds it into a reservoir having a capacity of 3,000 cubic feet. From the reservoir a second and similar pump lifts the water to a filtering apparatus capable of filtering 750 cubic feet of water in 12 hours. The water is then taken to the reservoir which supplies the boilers. A third pump forces the water of the condensers to a cooling apparatus which lowers the temperature of the water from 45 to 20 deg. C. on a volume of 600 cubic feet per hour. In case the well should fail the boiler tank is fitted out so that it can receive water directly from the city mains. The products of combustion are taken off by conduits which occupy the rear part of the boiler plant. The smoke can pass out by a series of movable gates either directly into the chimney or through a Green economizer having 10,000 square feet of heating surface. The coal which is brought upon barges to the wharf is taken thence and stored in the station yards. In feeding boilers the coal is loaded upon small cars which are run on a track

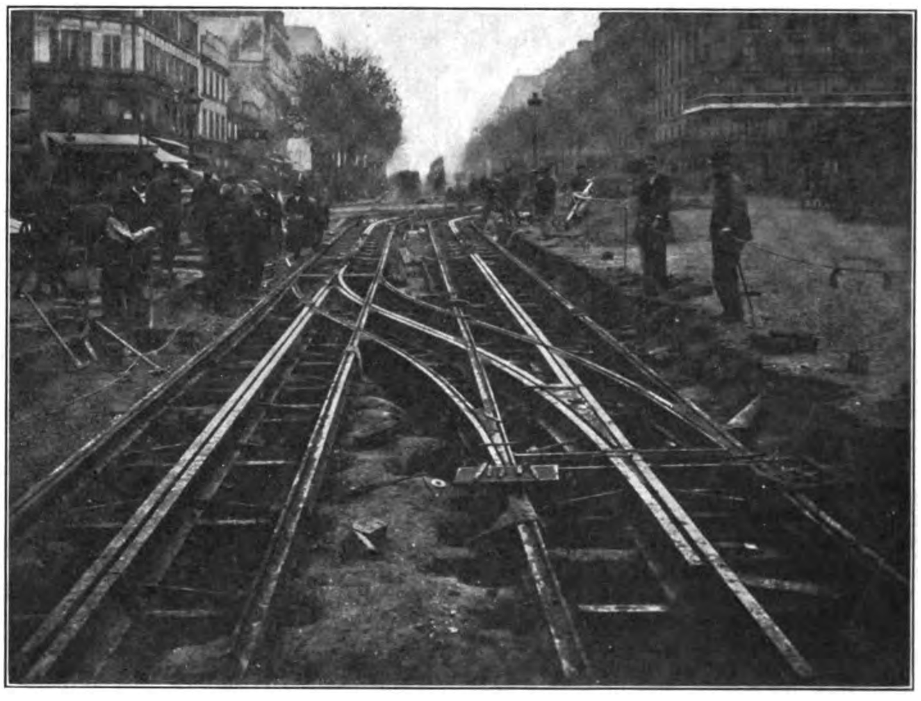


FIG. 10.—CENTER CONDUIT IN COURSE OF CONSTRUCTION.

arranged for the purpose in front of the grates.

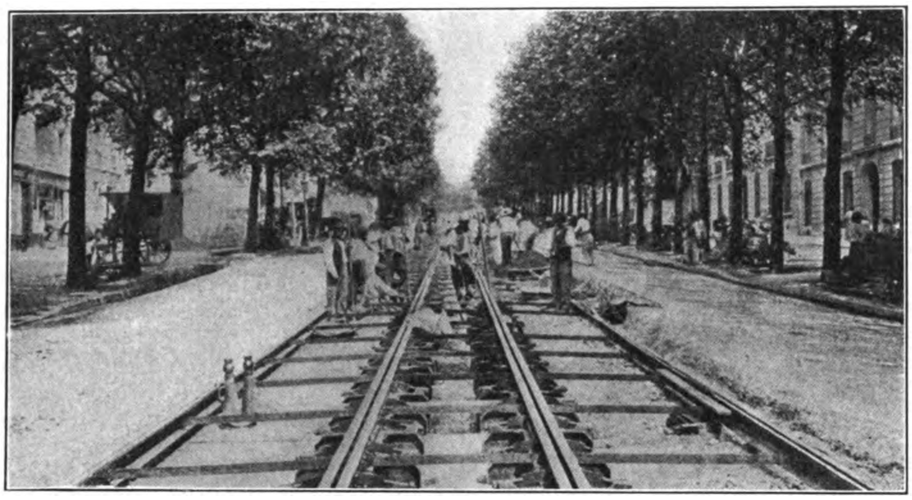


FIG. 11.—SIDE CONDUIT IN COURSE OF CONSTRUCTION.

The dynamo room is adjacent to the boiler room at a level of 10 feet above the ground, and has an area of 13,000 square feet. A general view of the dynamo room is shown in the leading engraving, which shows four of the direct connected generating sets. The plant contains five such units in all. The engines are of the Dujardin horizontal pattern and have a capacity of 300 horse-power each, being of identical construction. The engines are direct coupled to 225-kw. direct-current generators. The engines are cross-compound with a Corliss valve distribution. The high pressure cylinder of these engines measures 16 inches in diameter and the low pressure 30 inches; the piston stroke is 36 inches, and the speed 90 revolutions per minute. The engines are disposed so that they can be changed over from condensing to free exhaust by operating a set of valves provided for the purpose. The condensers have been installed in the basement below the dynamo room, and the condenser pumps are operated from the engines by a suitable transmission.

The five 225-kw direct-current generators for the traction system have been constructed in the Paris shops of the Thomson-Houston Company. The armatures are mounted directly upon the engine shafts together with a large flywheel; they are of the usual drum type built up of laminated iron and provided with ventilating segments. The 8 cast-steel field poles are bolted around the inner periphery of the cast-steel frame and contain a shunt winding of fine wire together with a series winding which assures the over-compounding of the machines. At no load they supply a voltage of 500, and on full load 550 volts. These machines have been designed so that all the parts are interchangeable and it is easy to take out the armature or remove one of the field poles with its coil, without disturbing the rest of the machine.

These machines will stand an overload of 25 per cent during half an hour without overheating. On the ordinary run they deliver a current of 450 amperes and none of the parts heat up more than 45 deg. C.

The switchboard contains 11 panels of white marble, and is made up of 5 panels for the machines, 4 for the feeders, 1 for the lighting and motors of the station and a panel in the center which contains the instruments for checking up the line. The generator panels, which are identical, contain an ammeter, field rheostat hand wheel, field switch, a quick-break switch which is placed in the bus-bar circuit and a Thomson meter. To the instruments on the central panel are connected the ends of the pilot wires which run to different parts of the main line, and the drop of voltage can be constantly observed.

A set of feeders which start from the station supply the traction line at different points. The feeder system is made up of 8 sheathed and insulated cables of 500 square millimeters section, having a total length of 11 miles of cable; 4 similar cables of 250 square millimeters section, with a total length of 4.2 miles of cable; and 4 cables of 150 square millimeters, with the same length as the former. This makes in all nearly 20 miles of cable.

The car-barn, which is one of the largest in Europe, is laid out so as to afford an easy inspection of the material, as well as repairs, and has an efficient motor-operated system for shifting the cars from one track to another. The total surface of this plant is 150,000 square feet, while the car-barn proper occupies a large building of steel construction having an area of 100,000 square feet.

Here are stored the 90 motor cars, 90 trailers, and 2 electric street sweepers which form the present outfit, or a total of 182 cars. A series of 30 or more tracks cover the interior of the building. Across the tracks run three traveling platforms for shifting the cars. Two of these platforms are used for the motor cars and measure 180 feet long by 24 feet wide. They are operated by motors of the railway pattern and standard controllers, and take the current by a set of contact shoes from copper bars placed beneath. The third platform, for the trailers, measures 156 by 15 feet. The current for the motor is taken from a conduit of the standard pattern by means of a contact plow.

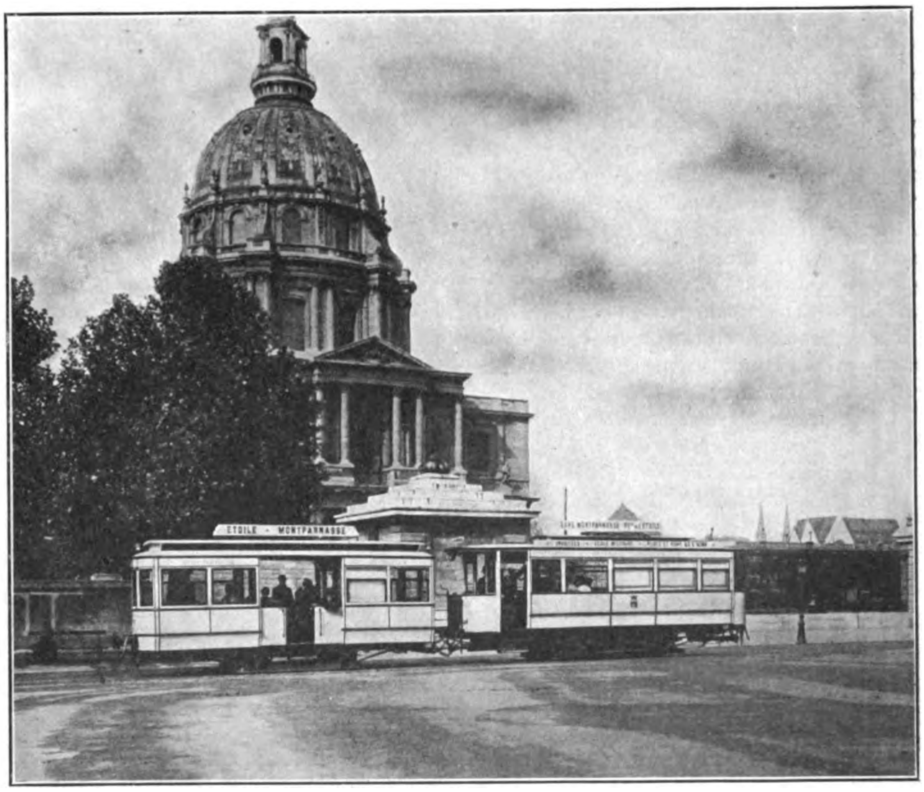


FIG. 12.—MOTOR CAR AND TRAILER.

The type of motor car and trailer which is used on the Paris system is illustrated by Fig. 12, which shows the cars in front of the Invalides. The motor car, to the right, is equipped with two G. E. 58 motors of 37 horse-power, with a controller on each platform. It will hold 36 passengers in the first and second class, but standing room is allowed only on the platforms, as is usually the case in France. The trailers, which are used only occasionally, contain 33 seats.

PREDETERMINING MAGNET WINDINGS.

BY GEORGE W. MALCOLM.

The article on magnet windings, in the January number of the paper, is so closely in accord with my own methods that I trust I may be pardoned the addition of some remarks on the subject, along the line of the article mentioned. I have been in the habit of determining the value of the current required to bring the coil to the working temperature by assuming that that current would in one hour raise the temperature of the coil one-third of the total rise for ten hours, and making the ten-hour rise the criterion of heating. Thus if the rise in temperature after ten hours in circuit was to be 60°, I assume that the current which produces a rise of 20° in one hour will cause the 60° rise in ten hours. This is not always true, of course, but it is near enough for practical work. Representing this by I_h, as in last month's article, and the current required to do the work by I_t, the proper length of the permanent coil is

$$L_t\sqrt{\frac{I_t}{I_h}} = L_c \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

L_t being the length of the test coil. Thus far, the procedure is exactly the same as described in the article of last month excepting the length of time taken to determine the heating limit. Beyond this point, however, the method differs. It is my custom to use either No. 8 or No. 14 wire in the test coil, and to determine the size of the wire in the permanent winding by comparison with the size of that in the test winding and the voltages of the two.

Dividing the voltage at the terminals of the test winding by the current passing, when the winding has been raised to the proper temperature as previously described, will give the warm resistance of the winding, of course, and multiplying this by the exciting current required for proper magnetic performance will give the e.m.f. that would be required at the terminals of the test winding to produce the proper excitation when the winding is warm; the ratio between this e.m.f and the e.m.f actually available for the working of the magnet is practically identical with the ratio between the size of the wire required for the permanent winding and the size of that used in the test winding. In formula shape:

$$\frac{\frac{E_h}{I_h}\times I_t}{E} = \frac{d_c^2}{d_t^2},$$ or written in somewhat simpler form:

$$\frac{E_h}{E}\times\frac{I_t}{I_h} = \frac{d_c^2}{d_t^2}\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

This latter expression is more convenient to handle, the ratio $\frac{I_t}{I_h}$ having been necessarily obtained already. When it is solved, one must, of course, take the nearest higher value for $\frac{d_c^2}{d_t^2}$ that can be obtained with standard wire sizes. In order to facilitate this choice, Table I has been prepared; this gives ratios of wire sizes through a sufficient range to meet all practical requirement. Having found the nearest available ratio of wire sizes from the table, represent it by R_a, and apply the formula

$$\frac{I_t}{I_h}\times\frac{E_h}{R_a} = E_c \quad\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

The value, E_c, thus obtained, will be the e.m.f. necessary to excite the *permanent* winding (of wire having a cross-section of $R_a \times d_t^2$ circular mils) to the proper degree when that winding is warm. This value will not agree with the e.m.f. actually available for the work unless the ratio $\frac{d_c^2}{d_t^2}$ obtained by means of formula (2) happens to be identical with one of the ratios in Table I. In the case of dynamo field magnet windings, the discrepancy will not be worth the trouble of compensating it by modification of the winding, for the reason that the actual voltage at the terminals of the winding in practice is not necessarily fixed at any one value beforehand, an adjustable resistance always being inserted in series with the winding. So far as such a winding is concerned, therefore, the result of formula (3) may be taken as final. This is also true of the shunt field winding of a constant-potential motor unless the machine is designed for operation at some very exact speed, which is very rarely the case.

TABLE I.

Wire in permanent coil smaller than wire in test coil.				Wire in permanent coil larger than wire in test coil.			
N-N_t	$\frac{d^2}{d_t^2}$	N-N_t	$\frac{d^2}{d_t^2}$	N_t -N	$\frac{d^2}{d_t^2}$	N_t -N	$\frac{d^2}{d_t^2}$
1	0.793	11	0.078	1	1.26	11	12.8
2	0.629	12	0.0618	2	1.59	12	16.15
3	0.498	13	0.049	3	2.	13	20.4
4	0.395	14	0.0389	4	2.53	14	25.7
5	0.313	15	0.0308	5	3.19	15	32.4
6	0.249	16	0.0245	6	4.02	16	40.9
7	0.197	17	0.0194	7	5.07	17	51.65
8	0.156	18	0.0154	8	6.39	18	65.
9	0.124	19	0.0122	9	8.06	19	82.
10	0.0984	20	0.0097	10	10.17	20	103.3

Note:—N represents the gauge number of the wire that is to be used in the permanent winding. N_t represents the gauge number of the wire in the test winding. The whole numbers, 1 to 20, in the 1st, 3d, 5th, and 7th columns are the differences between the two gauge numbers. Thus, with No. 8 wire in the test winding, if N—N_t = 6, the value of N is 14, which would be the gauge number of the wire to be used in the permanent winding.

In the case of an ordinary electromagnet, if the value of E_c obtained by formula (3) is more than 15 per cent below the e.m.f. at which the permanent winding is to be worked (it cannot possibly be more than 19 per cent below) it will ordinarily be found advisable to make the following correction:

Representing the number of turns of wire in the test coil by T_t, and the number of turns to be actually put in the permanent coil by T, this latter value will be given very closely by the formula

$$\frac{E}{E_c}\times\frac{T_t}{R_a}\times\frac{L}{L_t} = T\ldots\ldots\ldots\ldots(4)$$

in which L represents the length of coil actually adopted for the permanent winding. This value should be the nearest practical figure larger than the value, L_c obtained by means of formula (1). No allowance for differences in insulation thickness has been made in the foregoing formulas, and none is necessary if the wire in the test winding is not more than six or eight gauge numbers larger than the wire of the permanent winding. The latter, of course, will not contain as many turns as it theoretically should in order to make good the relation

$$d_c^2 \times T_c = d_t^2 \times T_t,$$

on which formula (4) is based, but it will usually be found that the discrepancy produces no seriously objectionable results, if the wire is wound properly; if it is "spun on" indiscriminately, no calculations will apply.

If the tests and calculations have been accurately made, the current taken by the permanent winding, at the voltage, E, will be

$$\frac{T_t\,I_t}{T} = I.$$

If this should be greater than is desired for operating economy, the length of the coil will have to be increased enough to permit increasing the number of turns to satisfy the equation

$$\frac{T_t\,I_t}{I'} = T',$$

in which I' represents the current allowable on the score of economy, and T' equals the number of turns necessary to reduce the current to that value.

If the magnet winding is to be worked at a certain current value regardless of the voltage at its terminals, the size of wire may be approximated by the formula

$$\frac{I}{I_t} = \frac{d_c^2}{d_t^2}\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2\text{-a})$$

instead of formula (2), and the nearest tabulated ratio, R_a, $\left(=\frac{d^2}{d_t^2}\right)$ is taken. The number of turns per coil in the permanent winding is, of course, given by the equation

$$\frac{I_t\,T_t}{I} = T,$$

and if the value I is a fixed one, this number of turns must be put in, even if it necessitates increasing the length of the coil; as a rule, however, the proper number can be obtained by slightly enlarging the girth of the coil, retaining the length at the value adopted from the result of formula (1).

If the temperature of the test coil, when given the proper excitation to the magnet, happens to be correct, so that no test is necessary to find the proper heating current, no correction in the length of the coil will be necessary, and if the permanent winding is put on evenly (not spun on criss-cross fashion) the relation between the size of wire in the test coil and that in the permanent coil will be

$$\frac{E_t}{E} = \frac{d}{d_t} \quad \dots\dots\dots\dots\dots\dots\dots\dots (5)$$

◆

THE TONE TEST.

BY A. DALLAM O'BRIEN.

Since the adoption of the multiple switchboard in telephone central offices, it has been necessary that some means should be provided whereby the condition of any line connected to the switchboard might be ascertained by any operator. It was this necessity that led to the introduction of the familiar "busy" test, which enables the operator to ascertain the condition of any line by placing the tip of one of a pair of connecting cords in contact with the sleeve of the line jack; in the event of the line being busy the operator is notified of the fact by receiving a slight click in her receiver, due to the flow of a current from the jack sleeve through a secondary winding of her induction coil to ground.

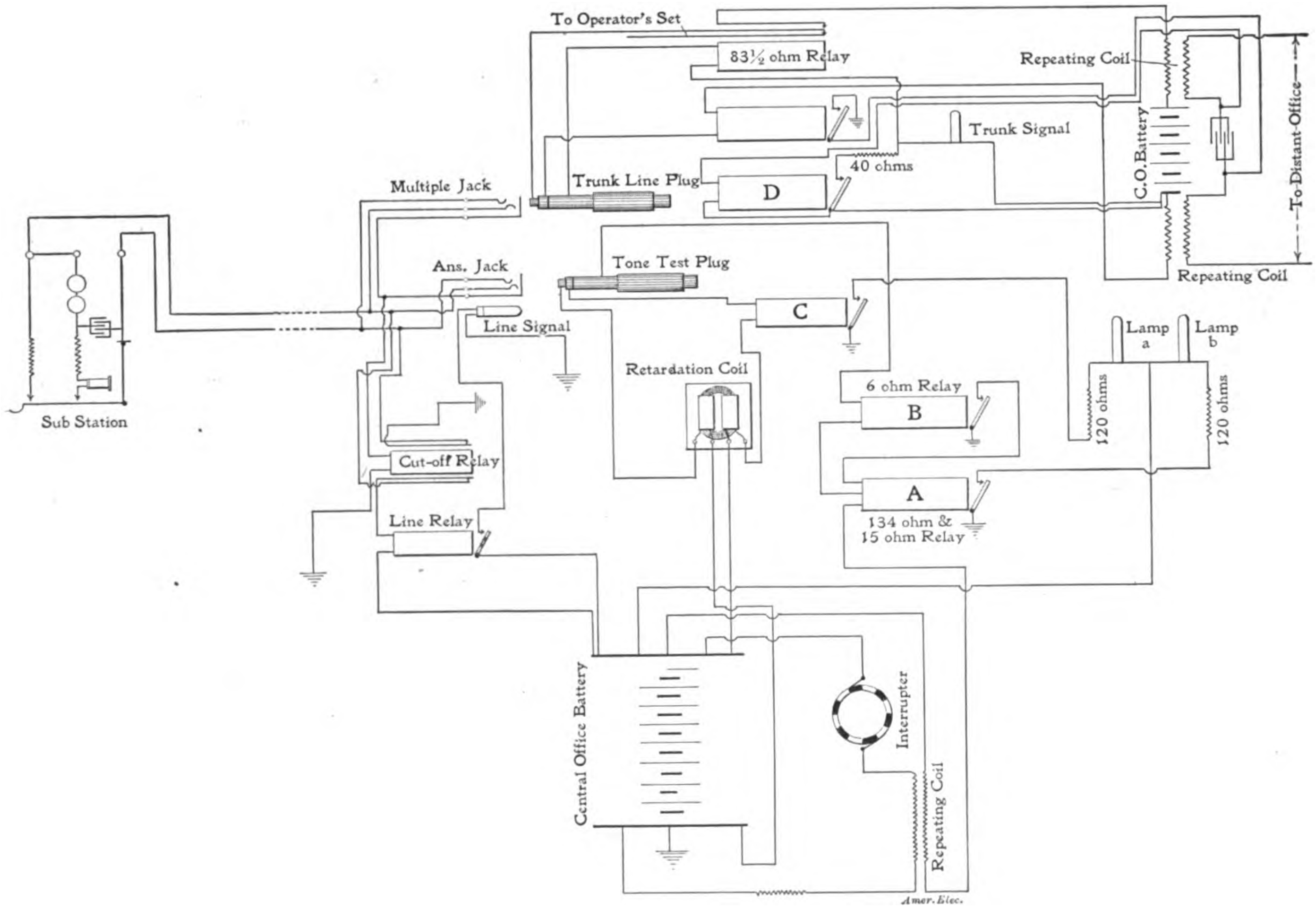


FIG. I.—DIAGRAM SHOWING SUBSCRIBER'S CIRCUIT, TONE TEST CIRCUIT, AND TRUNK LINE CIRCUIT.

With the advent of the common battery system, it became possible not only to expedite the work of an operator but also to give to the operators at the switchboard means of obtaining a more intimate knowledge of the conditions of the connected lines than had heretofore been possible. This end has been very largely accomplished through the use of distinctive test circuits, in which an interrupted current of a certain predetermined periodicity is applied to the sleeve of the line jacks in much the same way as the original "busy" test, the effect of this arrangement being that upon testing the line an operator instead of receiving the usual click hears through her receiver a musical tone of a character depending upon the periodicity of the interrupted current. At the present time, in large central offices several distinctive tone tests are used, the most prominent being the "out of order" test and the "long distance busy" test. It, of course, requires experience on the part of the operator to distinguish the different tests, but as the tones vary considerably a little practice will enable them to be distinguished with absolute certainty.

It is the purpose of this article to describe the principle and operation of the tone test as used in connection with calls completed over long distance and toll lines, as it was to this class of work that tone-test circuits were first applied. The completion of long distance and of toll calls involves practically the same method of operation on the part of the subscriber's operator, and in order to understand fully the significance of the tone test it is necessary that the operation involved in completing such calls should be perfectly clear. Each subscriber's operator's position is equipped with a calling circuit which terminates at the receiver of a recording operator, who is located at the long distance or toll office.

Trunk lines are provided between the local exchange and the above mentioned offices, these lines terminating in cords and plugs at the local offices and in jacks at the other end. Calling circuits are also provided between the offices, these circuits terminating at the receiver of the trunk operator at the local exchange. A subscriber wishing to make a long-distance call removes the receiver from the hook and signals the office in the usual way. The operator answers, and ascertaining that a long-distance connection is desired, instructs the subscriber to hang up the receiver and informs him that "Long Distance" will call him. The operator then places a tone-test plug in the jack of the calling line, and connecting her outfit to the calling circuit leading to the long distance office, informs the recording operator that the subscriber wishes to make a long-distance call. The recording operator makes a memorandum of the number of the calling line and passes it to another operator who connects her telephone set to the calling circuit leading to the trunk operator at the local office and repeats the number of the desired line. The local trunk operator assigns a trunk and places its plug in the multplie jack of the line desired and rings on the trunk or allows the long distance operator to ring, as the arrangement of circuits may require. The calling subscriber is thus connected to the long distance office and enabled to give directly the details of the connection desired. The further operation required to complete the call is not essential, so far as the tone test is concerned.

In Fig. 1 is shown a diagram of the subscriber's circuit to the local office, the tone test circuit and the circuit of a trunk line leading to a long distance or toll office. It must be understood that the arrangement of circuits shown herein is not always adopted, but as the principles involved in any case are the same this arrangement may be taken as a representative one. The circuit of the subscriber's line is the standard three-wire common battery arrangement whereby the removal of the receiver from the hook at the sub-station signals the operator by lighting a small incandescent lamp in the switchboard.

Assuming that the subscriber desiring to make a long distance call has signaled the office and informed the operator of the connection desired and that the operator has placed the tone test plug in the jack, the operation of the circuit can be followed from the diagram. Current from the battery flows through the winding of the repeating coil; thence through the two relays, *A* and *B*, to the sleeve of the tone-test plug; through the sleeve of the jack and cut-off relay to ground, thus operating the relay *B*, and the cut-off relay. The current which flows through the relay *A* under these conditions is not sufficient to operate it. When the long distance operator, having received a memorandum of the call, orders the line up over the calling circuit to the local office, the local trunk operator places the trunk line plug in the multiple jack of the calling line, and the connection between the sub-station and the long distance office is completed. The insertion of the trunk line plug in the multiple jack causes a rearrangement of the resistance connected in the circuit and forms a combination equivalent to that obtained in the circuit of an unbalanced Wheatstone bridge, allowing additional current to flow through the relay *A*, so that the relay is operated and current allowed to flow from the battery through the lamp, *b*, to the armature of relay, *A*, and thence to ground, thus lighting the lamp and notifying the subscriber's operator that the calling subscriber has been taken up by long distance. Upon receiving this signal, the operator removes the tone test plug and is through with the connection.

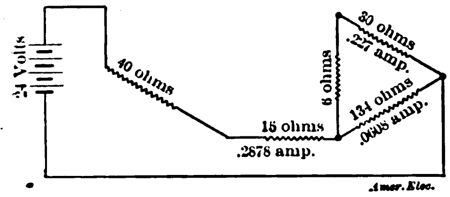


FIG. 2.

In order to show clearly just what occurs when the tone test plug is inserted, it is necessary to consider three different conditions. The first case occurs when the tone test is inserted in the subscriber's jack, and is illustrated diagrammatically in Fig. 2. Here we have the current flowing first through the 40-ohm winding of the repeating coil; thence through the 15-ohm winding of relay, *A*, where it divides, a portion flowing through the 134-ohm winding of the relay and the remainder flowing through relay, *A*, and the cut-off relay, the resistance of the latter being 30 ohms. The current which flows in the various branches of the circuit is indicated in the diagram, and it will be noted that about 0.06 ampere flows through the 134-ohm winding, and in this case relay, *A*, is not operated.

In Fig. 3 is shown the arrangement of the circuit when the local trunk operator has connected a trunk line to the jack of the calling subscriber; and in addition to the arrangement of resistances, shown in Fig. 2, there is inserted the remaining leg of the bridge which consists of the resistance of the trunk signal lamp (120 ohms) and the resistance of the 83½-ohm trunk relay. In order to find the distribution of current in this circuit, it is necessary to form the six equations resulting from the application of Kirchoff's laws and eliminate between them and solve for the value of the current in the different branches of the circuit. The values resulting from this process are indicated on the diagram, and in the solution of this problem it is necessary to state that the resistance of the battery leads has been considered as being negligible. A current of 0.07 ampere now passes through the 134-ohm winding of the relay *A*, and in addition, the current flowing through the 15-ohm winding of the same relay is considerably increased so that the relay is now operated and the signal lamp, *b*, lighted.

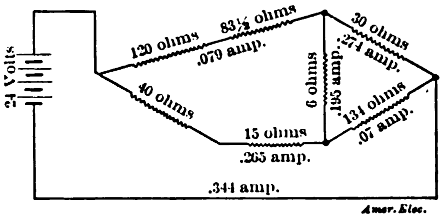


FIG. 3.

The case outlined above only occurs when the local trunk line operator, having made an assignment, connects the trunk with the jack of the calling line and the long distance operator fails to take up the trunk at the long distance end. When the trunk line is taken up by the distant operator, we have the conditions illustrated in Fig. 4. Here we have a 40-ohm shunt closed around the trunk signal, and consequently, instead of having 120 and 83½ ohms in one leg of the bridge, we have the 120 ohms resistance of the lamp in parallel with the 40-ohm shunt, giving an equivalent resistance of 30 ohms. The values of the current in the different branches of the circuit are worked out in the same manner as in the preceding case and are indicated in the diagram.

In Fig. 1 it will be noticed that two batteries are shown. This, however, is done merely for convenience in drawing; one battery is used to furnish all the current for the central office.

The tone test itself is produced by interrupting the flow of current from the battery by means of a suitable commutator, the number of segments on the commutator determining the pitch of the tone that it is desired to produce. This commutator is usually mounted on the shaft of the central office ringing machine and is rotated continuously. The interrupted current flows from the commutator through the primary winding of the repeating coil and a resistance to battery inducing a similar current in the secondary winding, which current flows to the sleeve of the tone test plug and thence to the jack sleeves of the line to which the tone test is connected. If any operator at the switchboard should receive a call for a line which for some reason is being held on a tone-test plug, she will upon testing hear in her receiver the peculiar hum caused by the interrupted current and will know that the line in question is not only busy at that instant but that it will continue to be occupied for a considerable length of time; consequently, the operator is in a position to say to her calling subscriber that the line desired is waiting for a long distance connection and that it will probably be some time before a local connection can be completed.

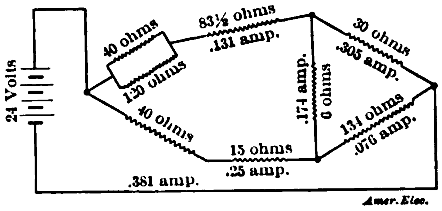


FIG. 4.

By means of the lamp *a*, the calling subscriber who is being held on the tone-test plug is able to signal his local operator in case there should be any delay on the part of the long distance operator in taking him up. By removing the receiver from the hook at the sub-station current is allowed to flow from the battery through one winding of the retardation coil, the relay *C*, the ring of the tone-test plug, thence through the subscriber's instrument; back through the tip of the plug and the other winding of the retardation coil to the opposite pole of the battery, thus operating the relay *C* and lighting the lamp *a*, which notifies the operator that the subscriber wishes to communicate with her. The insertion of the retardation coil in the circuit serves to prevent the impairment of transmission, which might result should the subscriber's operator fail to remove the tone test when the lamp *b* lights, the high impedance of the coil serving to prevent practically any flow of the voice current through the shunt circuit formed by the tip and ring strands of the tone test plug.

The trunk line circuit, shown in the diagram, is of a very common type and offers no difficulties, the only point that it is necessary to consider in connection with the tone test being the operation of the relay *D*, which serves to close the 40-ohm shunt around the trunk signal and extinguish the lamp. This relay is operated from the distant office when a plug is inserted in the trunk line jack, this action grounding the side of the line to which the relay is connected and allowing current to flow from the battery through the relay to ground. When the plug is removed at the distant office, the relay *D* releases its armature, the 40-ohm shunt is removed from around the lamp and the trunk signal is lighted, thus notifying the local trunk operator to take down the connection.

From the foregoing description it will be apparent that from the receipt of the call by the subscriber's operator until the connection is completed through to the long distance office, the subscriber's operator is thoroughly in touch with the situation and in case of delay can take the necessary steps to expedite the connection. At the same time, the calling subscriber is held in such a position that should the necessity arise he can obtain connection with the local office. This form of test has operated so successfully that it is being applied in telephone exchanges to meet a number of requirements, the essential feature being that each test should have a thoroughly distinctive tone in order that complications due to a confusion of signals may not result.

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Fly-wheel Design.—The fly-wheels of slow-running engines are imposing, and have to be designed very carefully to meet the conditions of fluctuating loads, whilst at the same time not exceeding the safe limit. Accidents are happily much rarer than they were, and this is, no doubt, due to the greater skill which is given to the design of the fly-wheel, and also to the fact that most slow-running engines nowadays are fitted with an automatic stop motion.

In a cast-iron fly-wheel rim the safe tensile working stress is reached, at a maximum peripheral velocity of 100 ft. per second, which corresponds to about 80 ft. to 90 ft. per second on the mean circumference; the maximum stress due to centrifugal force being then about 1000 pounds per square inch. If the rim is solid this means a factor of safety of eight, which is about the minimum. Flange-jointed wheels should not be run above 70 ft. to 75 ft. per second, whilst built-up steel wheels may be run at 130 ft. per second.

A good average value for the energy necessary to be stored in fly-wheels for electric lighting purposes is 2.9 foot-tons per electrical horse-power or for traction purposes 4 foot-tons. For a 500-kw. set with a two-crank engine, the rotating mass will weigh about 50 tons, for 1000-kw. about 60 tons, for 1500-kw. about 75 tons, for 2000-kw. about 100 tons, and for a 2500-kw. about 150 tons.—*Exchange.*

TELEPHONE ENGINEERING.

Erection of Cables.

BY F. J. DOMMERQUE.

After the messenger has been pulled into place, the reel with the cable that has to go up first, is taken to the pole ahead of the cable pole and the lagging is carefully removed; the screws must be taken out also, so that they cannot scratch the lead when the cable is unreeled. It is advisable to unpack the cable very carefully for two reasons; first, so as not to damage the cable, and second, so as to preserve the reel in good condition as it can be returned to the cable manufacturer to be used over again, if the factory is not too far. The reel usually has an opening through its center to allow a shaft to pass through; this shaft when passed through is provided with collars at each end, secured by set screws so that the reel is free to revolve but not to slide sidewise. Two wheels are then attached to the ends of this shaft, the wheels being of a larger diameter than the reel, so that the outfit when put together serves as a carriage for the reel. Outside of the wheels an iron fork may be attached so that it can be removed easily when a new reel is to be put on; this fork has a pole attached to it by means of which the carriage is drawn. A reel containing not more than 1,000 feet of cable (this is about all that can be pulled at the time) is mounted upon the carriage and wheeled about 125 feet ahead of the pole where the cable is to start from. The reel is so placed that the cable will reel off from the top. An inspector is placed right at the reel who is to watch for any defects in the cable—principally in the lead sheath —and prevent any defective cable from being hung.

To provide an incline for the cable from the reel to the first pole, a piece of No. 4 steel wire, if such a one is handy as a remnant from the messenger, or else a No. 6 wire, is run from the first pole to the ground near the reel. Now a one-inch rope as long as the cable or rather a little longer, is attached to the cable, which may be done in several ways; one method is to braid over the end of the cable the strands of the rope and terminate them in a head provided with a swivel to which the end of the rope is fastened; another method is to bend a flat iron bar in the shape of a U and have the two side pieces fit the cable; from four to six screws are driven through the two side pieces with the cable end between them. At the bend a swivel is provided to which the rope is attached. At the first pole a wooden pulley block is located with its top just below the messenger to facilitate the running of the cable. It is therefore necessary to station two men upon the first pole, one to lay the rope and the cable over the pulley and guide it while it is sliding along, and the other one to hook the cable to the messenger. One man is to be stationed upon every pole thereafter for the purpose of passing the messenger over the cable supports. At the reel, besides the inspector, three men are needed. At the other end of the rope a winch is stationed driven either by horse, steam or electric power requiring the attendance of two men for the operation of the winch and one to watch the slack. Care must be taken that the velocity of the rope is not too high, else the men will not be able to fasten the hangers fast enough.

There are a number of hangers on the market which may be divided into two general classes, namely, non-metallic and metallic hangers. Hangers of the first class consist of a galvanized steel "goose-neck" to hook over the messenger and a marlin or leather or cotton strap which is impregnated to make it withstand the influence of the weather. This string or strap is looped around the cable. The metal hanger has also a galvanized steel hook to hook over the messenger, this hook being usually a double loop so as to obtain a wider bearing surface; to this a flat strip of zinc is attached which is drawn around the cable until it hugs the cable tight and then it is locked by the hook. Another metallic hanger is made of malleable iron in one piece. It is attached to and removed from the cable by a pair of special tongs.

The non-metallic hanger has the disadvantage that lightning may in its flight along the messenger burn the hangers and let the cable fall to the ground; another disadvantage is that it does not have a fixed position upon the cable.

The solid metallic hanger has the disadvantage of inflexibility; if such a hanger is caught in some obstacle while the cable is pulled along, it is sure to damage the cable.

The zinc strap hanger avoids all these objections and therefore seems the best one; it is also durable.

Marlin hangers cost from $5 to $10 per thousand according to size of cable. Zinc-strap metallic hangers cost about $30 per thousand.

Returning now to the reel, the rope is attached to the cable and pulled over the pulley or sheave at the first pole then along the entire line and finally laid upon the winch to be wound up. Now the cable starts to unreel at a slow speed, say 12 feet a minute, and one man marks off the points where the hangers are to be attached, allowing as a rule 20 inches between hangers (never more than 24 inches at the outside) the next man attaches the hangers at the marked points, and the third one stationed at the reel hooks the hangers upon the steel guide wire. It is not necessary to hook all the hangers, only every fourth or fifth. As the hangers reach each man on a pole, he unhooks them again as soon as they have passed the messenger support. When the cable reaches the last section all men hook all the hangers so that when the cable is in place, all hangers are upon the messenger. If the cable, when in place, is too slack a man can ride the cable in a cable car and straighten out the cable either by hand or by a piece of soft wood and a hammer. Such cable car consists of two trolleys attached to one side of an iron bar; from the bar a seat is suspended. The car is pulled along by a rope.

There is still another method of suspending the cable from the messenger, namely, by means of a continuous marlin string. This method, however, has the disadvantage that when the string breaks at one point an entire section of cable becomes unfastened; it also has the disadvantage of the possibility of lightning burning the marlin mentioned before in connection with marlin hangers. In this method the cable is hung from the messenger in snatch blocks; then beginning from the first pole the marlin string is tied to the messenger and reeled upon a so-called "spinning jenny," which consists of two pieces of wood, forming a hollow cylinder when put together. To the spinner a rope is attached by which it is pulled along to the next pole by a man stationed upon the pole; while gliding along the messenger the marlin string unreels and ties messenger and cable together. A new piece of string is started at every pole. But for the above-mentioned disadvantages it would be a clean-cut way of suspending the cable.

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PRELIMINARY WORK TO LAYING OUT A CONTACT RAIL SYSTEM.

BY WM. A. DEL MAR.

This article deals with the practical problems with which a draughtsman has to contend when preparing to layout a system of contact rails. This work really belongs to the civil engineer, but in actual practice it usually falls in the hands of the electrical draughtsman—that unfortunate individual who must know something of every branch of engineering.

When an entirely new railway is being projected the contact rail man has a fairly simple task, for the drawings of the projected track work can be altered to meet the requirements of the electrical engineer. When, however, an existing steam line is being converted, as is the case of the Manhattan elevated road, for example, the contact rail problem involves some complications, because the plans must be made to fit the existing road. In this case, the contact rail engineer has to begin by taking measurements of the track work in order to make drawings of the crossovers and other complications. Two men are required for this work, and they only require a linen tape line to make the measurements with. A linen tape is better than a steel one, as it is easier to swing it out of the way of trains. Furthermore, if any live rail were already installed a steel tape might be burnt by contact with the rail and track. In such a case it is necessary to be careful even with a linen tape as the thin wires which are woven into it for the purpose of giving strength, are apt to be fused by contact with the rail.

A typical turnout is shown diagrammatically in Fig. 1, where the lengths to be measured are given; *F* is the distance from the point of the switch to the point of the frog, and is called the "frog distance"; *D* is the length between the adjacent frogs, and *Z* the distance apart of the track centers. In such a diagrammatic view the lines represent the gauge lines of the track rails. On the other hand, when a contact rail is represented by a line, it is the center line that is given. Fig. 2 shows a rail section in which the dotted line, *G G*, represents the gauge line, which is, of course, on the inside of the track. In Fig. 3 the gauge lines of a frog are denoted by heavy lines. The "point" of the frog is the intersection of the gauge lines, and is indicated by *f*.

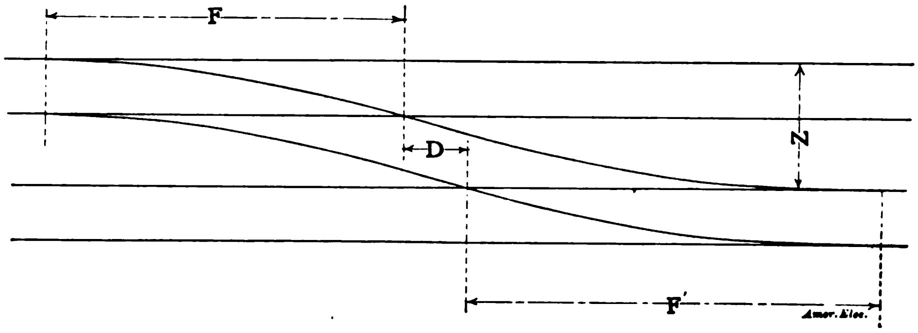

FIG. 1.

It is important to distinguish between the "point" of a switch and the "point" of a curve. The point of a curve is the point at which the curved gauge line is tangential to the straight gauge line. In practice, however, as the curved rail cannot be brought to a mathematical point where it meets the straight one, it is cut off where it begins to be too thin. The place where the curved rail actually ends, is called the point of the switch. The distance in feet between the point of curve and point of switch usually amounts to something like one-quarter of the square root of the radius in feet of the turnout curve. In actual practice, however, this quantity is widely variable, so that the rule given can only be regarded as an approximation.

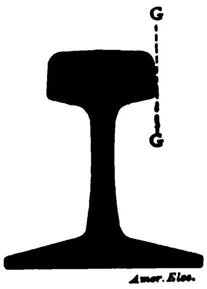

FIG. 2.

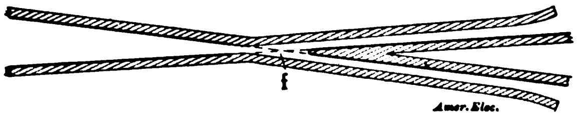

FIG. 3.

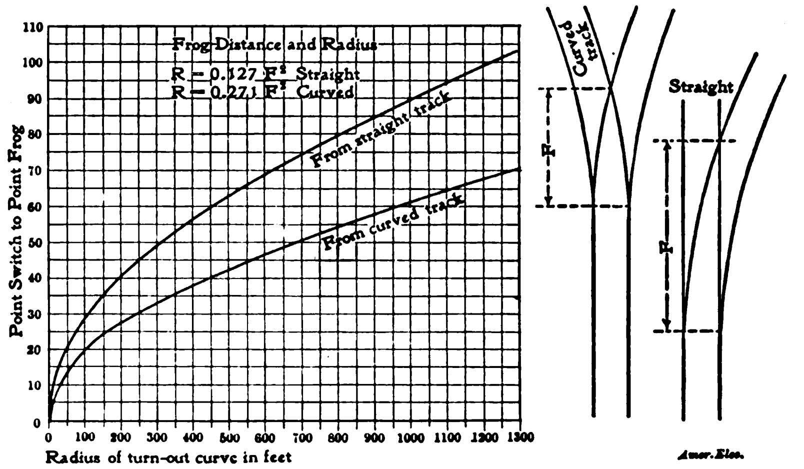

FIG. 4.

Two curves which give the radius of a turnout curve in terms of the frog distance, *F*, are given in Fig. 4. These curves are extremely useful, as the draughtsmen may at a glance find what radius of curve to use in making his drawing from field sketches. Fig. 5 shows the relation between the frog angle and the radius, the frog angle being that between the straight rail and the tangent to the curved one at the frog point. These curves are only correct for the standard gauge of 4 ft. 8½ ins. When drawing out track work, the curves are drawn by means of wooden or celluloid templates consisting of circular arcs of various radii.

Frogs of different angles are distinguished by their "number." The frog number is

$$N = \frac{1}{2} \, \frac{1}{\tan \frac{1}{2} \Theta}$$

where Θ is the frog angle. This relation is shown by the curve in Fig. 6. The frog number is measured by the ratio of the lengths $a + b$ and $c + d$ in Fig. 7. It is useful in the case of a turnout such as shown in Fig. 8, in which case

$$\text{Radius} = 2N \left[B - \frac{Z - G}{\tan \Theta} \right]$$

Where the adjacent tracks are diverging as shown in Fig. 9, the distance between centers of tracks should be measured at every frog and switch point, as indicated at Z_1, Z_2, Z_3.

Occasionally, when laying out the track work from rough sketches, the two curves of a turnout do not meet, as shown in Fig. 10. This often arises from an error in measuring or setting off the track centers.

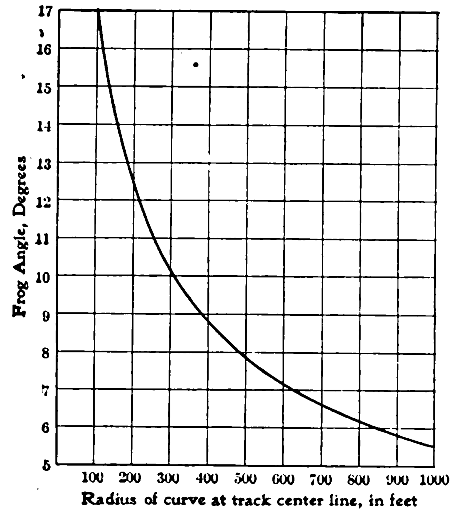

FIG. 5.

Sometimes, however, it happens that these may be correctly done, and yet the curves do not meet. This is due to the fact that the rails are not bent into exactly circular arcs, so that in such a case curves must be chosen that will make the turnout continuous and free from sharp bends.

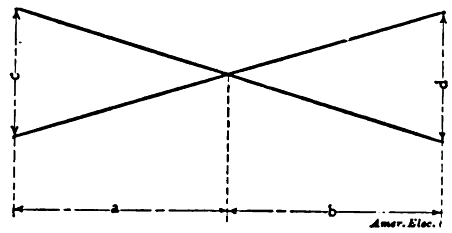

FIG. 7.

The suggestions given above should be sufficient to enable the track work to be drawn from field sketches in a manner sufficiently accurate for the purposes at hand. The next matter to attend to is the contact rail itself. In order to do this, it is first necessary to draw an outline plan of the car that will be used, to the same scale as the track work drawings—say, ¼ in. to the foot. Such a plan is shown in Fig. 11, in which the points *W* represent the the wheels; *S*, the contact shoes, and *K* the king pins. This had better be made of celluloid, with a large pinhole at each point *S*. In order to lay out the contact rail, the car is run along the tracks with the points *W* on the rails and a pencil stuck in one of the pinholes The line traced by the pencil represents the center line of the shoe path, and therefore that of the contact rail. Such a line should be made on each side of the car. In cases where there are sharp curves, it will not do to run the wheel points *W* along the tracks, as an error will arise owing to the truck rotation not being represented. In such a case the king pin points must be run along a track center line.

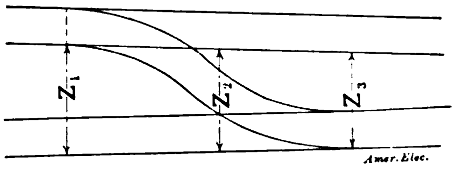

FIG. 9.

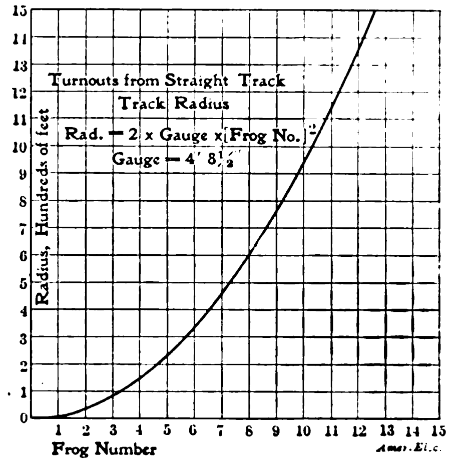

FIG. 6.

The exact location of the contact rail inclines on each side of a track rail intersection depends on a number of conditions, an important one of which is the extent to which the equalizer bar and journal box of the cars project outward. If there be a train bus line connecting all the cars, the end inclines may be situated many feet back from the switch point or frog, but if there is no such bus line the contact rail will probably have to be terminated in a "cross incline" extending as near as possible to the switch point or frog. The various problems which arise in this connection are foreign to the subject of this article, and cannot be dealt with in a general way.

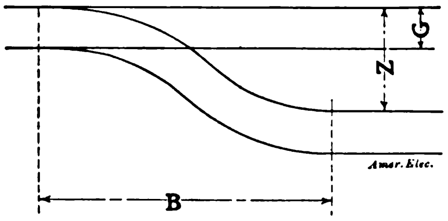

FIG. 8.

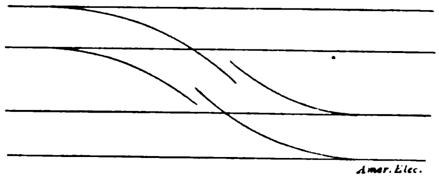

FIG. 10.

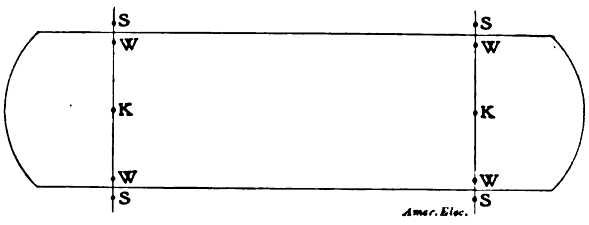

FIG. 11.

THE TURBINE PROBLEM.

BY H. F. SCHMIDT.

The history of the turbine has been given so often that it would be useless to repeat it at this time; but as no adequate presentation of the principles and theories underlying the construction of vapor turbines has appeared, it was thought by the writer that a short discussion would be of interest.

All vapor turbines depend for their operation upon the impulse and reaction of a moving fluid upon the blades of the turbine, and thus far they follow the water turbine in principle, the difference being in the character of the working fluid. The lighter the medium employed, the higher must be the peripheral velocity of the wheels. This is seen at once by examining the familiar formula of hydraulics, $V = \sqrt{2gH}$. This formula is approximately true for gases, but when used for gases, H is the height of a column of the gas the weight of which would equal the existing pressure per square foot. Hence, this formula becomes, $V = \sqrt{2gPv}$, where P is the pressure per square foot and v is the specific volume of the gas in cubic feet at the given temperature and pressure. As this formula only gives the velocity due to the static head, while gases and vapors under pressure expand adiabatically in the nozzle doing work at the expense of the heat energy of the gas, the actual velocity will far exceed that calculated in this way.

The adiabatic expansion is taken into account in the following formula:

$$V^2 = \frac{2g}{w}\, p_1^{\frac{1}{r}}\left(p_1^{\frac{r-1}{r}} - p_2^{\frac{r-1}{r}}\right) = \frac{2g}{w_1}\,\frac{r}{r-1}\,p_1 \left(\frac{T_1 - T_2}{T_1}\right) \qquad (1)$$

which gives the true theoretical velocity acquired by the jet in feet per second. In this p_1 and T_1 are respectively the initial pressure in pounds per square foot and absolute temperature in degrees Fahrenheit; p_2 the final pressure, T_2 the final temperature, w_1, the initial specific weight of the gas, and r the ratio of the two specific heats of the gas (having a value of 1.408 for air and all perfect gases). If to r the value of 1.065 is given, the formula will give very closely the velocity of saturated water vapor, or the following formula which is correct for all saturated and superheated steam-like vapors may be used:

$$V^2 = 2gJ\left\{ c\left[T_1 - T_2\left(1 + \log_e \frac{T_1}{T_2}\right)\right] + \frac{T_1 - T_2}{T_1}\,h_1 \right\} + \frac{2g}{w_1}\,\frac{r}{r-1}\,p_1\left[\frac{T_1^1 - T_2}{T_1}\right] \qquad (2)$$

Here J is Rowland's mechanical equivalent of the heat unit, 778; T_1 and T_2 the absolute temperatures corresponding respectively to the initial and final pressures; h_1 the heat of vaporization at the temperature T_1; T_1', the temperature to which the vapor is superheated; w_1 the specific weight of the superheated vapor at the pressure p_1 and temperature T_1'; c the specific heat of the liquid (which for water is unity), while r will have a value about 1.38 for superheated steam.

In this connection it will be remembered that if the gas comes to rest without doing work, the kinetic energy stored in the moving mass will reappear as heat, and in the case of a steam-like vapor, if initially dry, it will become superheated.

In order to find the sectional area of the orifice for a given power it is necessary to know the weight of medium discharged per unit of area under working conditions; the following formula gives the theoretical weight in pounds per second for a perfect gas per square inch of section at point of least diameter.

$$W_a = \frac{(0.527)^{\frac{1}{r}}}{144}\sqrt{2gw_1p_1\left[1-(0.527)^{\frac{r-1}{r}}\right]} \quad (3)$$

For vapors,

$$W_a = \frac{\sqrt{2gJ\left\{c\left[T_1-T_2\left(1+\log_e\frac{T_1}{T_2}\right)\right]+\frac{T_1-T_2}{T_1}h_1\right\}}}{144V_2\left[\frac{h_1}{T_1}+c\log_e\frac{T_1}{T_2}\right]\frac{T_2}{h_2}} \quad (4)$$

These can only be used when the ratio of pressures is less than 0.527 for gases and less than 0.58 for steam. When the ratio is greater than these values, the formula for gases becomes:

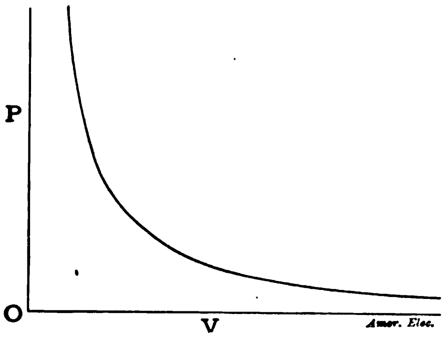

FIG. 1.—ADIABATIC CURVE.

$$W_a = \left(\frac{p_2}{p_1}\right)^{\frac{1}{r}}\frac{1}{144}\sqrt{2gw_1p_1^{\frac{1}{r}}\frac{r}{r-1}\left[p_1^{\frac{r-1}{r}}-p_2^{\frac{r-1}{r}}\right]} \quad (3\text{-a})$$

In these formulas the symbols used have the same meaning as previously given; but in the formula for vapors in cases where the ratio of p_2 to p_1 is less than 0.58 the symbols with the subscript ($_2$) have values corresponding to a pressure of 58 per cent of the initial, regardless of what the actual final pressure may be.

From the adiabatic curve for perfect gases given in Fig. 1, it is evident that as the pressure decreases more rapidly at first than the volume increases, the velocity of the jet will increase more rapidly than the volume. However, a point will be reached at which the volume will increase at a much greater rate than the pressure decreases with a corresponding lesser increase of the velocity than the volume. Hence, it follows that the sectional area of the orifice must at first decrease and then increase again. Theory and experiment show that the pressure at the smallest section of an orifice will in the case of perfect gases be 52.7 per cent of the initial pressure, and for steam 58 per cent. This divides the construction of nozzles into two cases, according to whether the ratio of maximum to minimum pressure is greater or less than the critical value. As long as the ratio is less than the critical value, the weight of medium discharged per unit of area will be independent of the pressure, but for greater ratios the weight is a function of the pressures. A nozzle for the first case simply decreases in diameter, but for the second case a diverging mouthpiece must be added. Theoretically the nozzle might be made almost any length desired, either very long or very short. However, owing to the fact that gases and vapors meet with considerable resistance when moving over surfaces at high velocities on account of the formation of eddies and contraction of the vane, there will be a certain length of nozzle that will give the best results. This length must be determined by experiment as no theoretical formula could take into account all the disturbing influences which affect the velocity. Formula (3) gives the sectional area of the nozzle in square inches at any point at which the pressure p is known.

$$A = \frac{144\ W}{\left(\frac{p}{p_1}\right)^{\frac{1}{r}}\sqrt{2gw_1\frac{r}{r-1}p_1\left(\frac{T_1-T}{T}\right)}} \ldots (4)$$

W is the weight of the gas discharged in pounds per second, w_1 the initial specific weight of the gas in pounds, and r has the same value as before, 1.408. This formula is only true for perfect gases, that for vapors being complicated by condensation during adiabatic expansion. For this case, the following formula may be used to determine the area of the nozzle in square inches:

$$A = \frac{144\ Wv\left(\frac{h_1}{T_1}+c\log_e\frac{T_1}{T}\right)\frac{T}{h}}{\sqrt{2gJ\left\{c\left[T_1-T\left(1+\log_e\frac{T_1}{T}\right)\right]+\frac{T_1-T}{T_1}\right\}}} \quad (4\text{-a})$$

This, it must be remembered, is only true for vapors which condense during expansion. The characters here used to designate the various quantities are the same as for the other formulas for saturated vapors, with the addition that v is the specific volume of the vapor at the pressure p.

Unless the sectional area varies in accordance with this formula, complete expansion cannot take place and the velocity acquired by the jet will be less than had the expansion been completed. A formula for the horse-power per square inch of nozzle area can be obtained by combining the formula for velocity with the formula for the weight per square inch, which for gases will take the form:

$$\text{Horse-power} = \frac{(0.527)}{144 \times 550} \times \sqrt{\frac{2g}{w_1}p_1\frac{r}{r-1}\left[1-(0.527)^{\frac{r-1}{r}}\right]} \times \left[\frac{r}{r-1}p_1\frac{T_1-T_2}{T_2}\right] \ldots (5)$$

For ratios of p to p_1 less or greater than 0.527 the formula becomes:

$$\text{Horse-power} = \frac{1}{550 \times 144} \times \left(\frac{p_2}{p}\right)^{\frac{1}{2}}\left(\frac{2g}{w_1}\right)^{\frac{1}{2}}\left[\frac{r}{r-1}p_1\left(\frac{T_1-T_2}{T_1}\right)\right]^{\frac{3}{2}} \quad (5\text{-a})$$

For steam-like vapors, the corresponding formula will be:

$$\text{Horse-power} = \frac{J}{550} \times \frac{\sqrt{2gJ\left\{T_1-T\left(1+\log_e\frac{T_1}{T}\right)+\frac{T_1-T}{T_1}h_1\right\}}}{144\left(\frac{h_1}{T_1}+\log_e\frac{T_1}{T}\right)\frac{T}{h}V} \times \left[T_1-T_2\left(1+\log_e\frac{T_1}{T_2}\right)+\frac{T_1-T_2}{T_1}h_1\right] \quad (5\text{-b})$$

in which the temperature and specific volume symbols without subscripts are those corresponding to a pressure of 0.58 of the initial pressure (for steam).

Having discussed the fundamental formula for turbines, it next becomes necessary to extend them, and enlarge upon them, so that multiple stage turbines may be considered. As there will necessarily be a large number of symbols used, it will be well to explain, first of all, their meaning.

All jet velocities will be designated by capitals, thus, V_{1a}^2 and V_{2b}^3, indicating the square of the initial jet velocity in the first stage, and the cube of the final velocity of the jet in the second stage respectively; u_a, u_b, u_c, represent the bucket velocities in the first, second and third stages respectively. In order to make the formula perfectly general, let there be n stages in the expansion, and let the bucket wheels in the various stages be of the same, or different diameter; that is, the bucket velocities may or may not be the same as in the Parsons or Rateau turbines.

Before proceeding with the nozzle calculations, it is necessary to find exactly what portion of the expansion must take place in each stage, which, of course, is determined by the bucket velocity in each stage since it is desired to have the initial velocity approximately equal to twice the bucket velocity. Now since it takes an amount of energy $E = \frac{w}{2g}V_1^2$ to impart the velocity V_1 to a mass of vapor $\frac{w}{g}$, it appears that the total work of expansion between the initial and condenser pressures must be divided between the different stages in proportion to the square of twice the bucket velocities, or more correctly, in proportion to,

$$\mu^2 = \left(\frac{V_1\cos\phi + V_2\cos\theta}{2}\right)^2$$

ϕ being the angle of entrance and θ the angle of exit.

Further, since the expansion in each of the nozzles is adiabatic, the entropy of the vapor remains constant, and since the energy transformed into work is equal to the product of the temperature change times the change of the entropy factor, it follows that the temperature range in any stage will equal the total temperature change into twice the square of the bucket velocity of that stage, divided by the sum of the squares of twice the bucket velocities in each of the remaining stages. What is meant here by the square of twice the bucket velocity, is really the square of twice that bucket velocity which makes the efficiency of the turbine a maximum, the formula for which is given in another part of this article.

The temperature range for each stage having thus been determined, and the exact initial velocity having been calculated for each stage, it is only then necessary to calculate the nozzle area required to pass the weight of vapor remaining in that stage. Owing to the expansion being adiabatic, some of the vapor will condense in the first stage nozzles, but as the pressure in the second stage chamber is lower than in the first stage, the water condensed in the first stage nozzles will partly evaporate if drained into the second stage chamber, and can thus be made to do additional work in the third stage nozzles. This process of draining the water of condensation in one expansion into the chamber of the succeeding stage is, of course, continued up to the final stage, at which point the water of condensation escapes with the exhaust into the condenser. Also since the vapor as it leaves the last bucket of the first stage has a velocity V_{2a} its kinetic energy will be $\frac{1}{2}\,\frac{X_{2a}}{g}\,V_{2a}^2$ which, as the vapor comes to rest, will reappear as heat, re-evaporating a quantity of the condensed liquid held in suspension by the vapor, equal to $X^1{}_3 = \dfrac{\dfrac{X_{2a}\,V_{2a}^2}{2g}}{J\,h^1{}_2}$ pounds, and hence there will be a quantity, $X_{1b} = X_{2a} + \dfrac{X_{2a}\;V_{2a}^2}{2g\,J\,h_{2a}}$ acting in the following nozzles $= X_{2a}\;\left(1 + \dfrac{V_{2a}^2}{2gJh_{2a}}\right)$. The amount of liquid thus re-evaporated in each stage must be calculated and added on to the vapor remaining after the expansion in the preceding nozzles. If L_2 is the total heat of one pound of the liquid at a temperature T_{2a}. then the amount of re-evaporating when drained into the second stage chamber in which the temperature is T_{2b} will, if the corresponding heat of evaporation is H_2 be $\dfrac{L_2}{H_{2b}}$ pounds, which amount must be added to that operating in the third stage nozzles and similarly for each of the following stages. Having thus calculated the portion of the original one pound of vapor entering the first stage nozzles which is effective in each of the following stages, the horse-power developed per pound of steam can be found, and hence the weight of steam that must pass through each of the nozzles, from which, by means of the formula for the weight of medium passing through a nozzle per square inch of cross section, and the area formula, all the dimensions of the nozzles can be calculated. The calculation for the nozzles for each stage is then executed in the same manner as for a single stage turbine, the pressure in the preceding stage casing being taken as the initial pressure, and the pressure in the casing of the stage, for which the calculations are being made, is used as the final pressure.

A complete detailed explanation of the method of actually making the calculations for a multiple stage turbine would take far more space than can be given at this time, but the foregoing outline, combined with a little "horse sense" will suffice.

As there is no steam indicator for the turbine, there is no way of finding the actual work done by the fluid; hence the best way to state the efficiency of the turbine is to express it in terms of the theoretical consumption per horse-power per hour. The weight of fluid per horse-power per hour may be obtained by dividing the weight per unit area per hour by the horse-power developed per unit nozzle area. For vapors, this will be as follows:

$$W_p = \frac{1{,}980{,}000}{778\left\{T_1 - T_2\left(1 + log_e\,\frac{T_1}{T_2}\right) + \frac{T_1 - T_2}{T_1}h_1\right\}} \qquad (6)$$

By the same process, the formula for the weight of gas per horse-power per hour is obtained:

$$W_p = \frac{1{,}980{,}000}{\frac{p_1}{w_1}\,\frac{r}{r-1}\left[\frac{T_1 - T_2}{T_1}\right]} \ldots\ldots\ldots\ldots\ldots (6\text{-a})$$

The efficiency of a vapor turbine will be, therefore,

$$E = \frac{1980000}{\text{Actual weight of vapor per h.p. per hour}} \times \frac{1}{778\left\{T_1 - T_2\left(1 + log_e\,\frac{T_1}{T_2}\right) + \frac{T_1 - T_2}{T_1}\right\}h_1} \qquad (7)$$

and for gas turbines,

$$E = \frac{1980000}{\text{Actual weight of gas per h.p. per hour}} \times \frac{1}{\frac{p_1}{w_1}\;\frac{r}{r-1}\left[\frac{T_1 - T_2}{T_1}\right]} \ldots\ldots\ldots\ldots\ldots (7\text{-a})$$

Using the formula for the velocity of vapors and assuming an initial pressure of 150 pounds per square inch absolute and a pressure of one pound absolute in the condenser, the resulting velocity of the jet of steam will be 3950 feet per second. This enormous velocity is almost 75 per cent greater than that of a shot from one of our large modern rifles. In order to obtain maximum efficiency, the velocity of the buckets must be half this value, which is so great that even the most tenacious material known could not withstand the resulting centrifugal strain, even though the wheels were made of large diameter. How to obtain with this enormous jet velocity the maximum efficiency without having prohibitory bucket velocity is the turbine problem.

This has been accomplished in two general ways, in both of which a series of revolving bucket wheels and stationary guide blades are grouped alternately. These methods are broadly represented by the Parsons turbine, which is of the reaction type, and the Curtis turbine, which operates on the impulse principle. Each of these turbines accomplishes the desired result by reducing, in stages, the velocity of the issuing jet of steam. The bucket wheels do not travel at one-half the velocity of the jet, but considerably less, so that the fluid leaving the buckets has a backward velocity relative to the revolving wheel. If it be reversed in direction by a set of guide blades, it may be caused to impinge on a second set of buckets, and so on, until the velocity is practically reduced to zero. In the Parsons turbine, the steam enters the first set of buckets without having been considerably expanded and at a comparatively low velocity; expansion takes place continuously through the buckets and guide blades, and as the velocity is being constantly increased by expansion, it is at the same time being constantly reduced by its passage through the buckets till at last it leaves the turbine almost devoid of motion. Hence, it is evident that as the velocity of the fluid through the turbine is almost constant, and the volume of the fluid is constantly increasing, the area through the buckets and guide blades must be correspondingly increased; and as with this system the entire circumference of the wheels must be used, in order to avoid making the blades of too great radial depth, the diameter of the wheels must be increased from the admission to the exhaust end of the turbine. In this type, the buckets are filled with expansive fluid, which on account of the difference in pressure between adjacent rows of buckets will tend to leak around the moving and stationary blades; it is necessary to have the clearance spaces between the stationary and revolving parts as small as possible in order to avoid excessive leakage. Regulation for changes of load is secured in the Parsons turbine by admitting the steam intermittently, the number of impulses per unit of time remaining the same; and the sole function of the governor is to fix the duration of admission. The result of this is illustrated by Fig. 2, in which the ordinates are pressures and the abscissæ equal intervals of time. The Dow turbine is of this type, but is of the outward radial flow type instead of being of the parallel flow type like the Parsons machine.

In turbines of the Curtis and Rateau type the steam is first expanded in a number of nozzles, attaining an extremely high velocity, which is then reduced in stages by passing the steam through a series of alternately moving and stationary blades. In the Curtis turbine, total expansion is not carried out in the first set of nozzles, but takes place in four or more stages, except in the earlier machines in which there are two moving wheels and two stages of the expansion. In the Rateau machine as many as twenty-five stages are employed, the reason for which is that if expansion is completed in one nozzle, the initial velocity will be so great that in order to have the number of revolutions per minute small and not have the diameter of the wheel excessive, the number of sets of bucket wheels and intermediates which must be employed will be so great that considerable loss in efficiency will result on account of the fact that much of the energy will be expended in overcoming friction and the formation of eddies. If, however, the expansion is divided into a number of stages, the initial velocity in each stage will be much reduced and the number of bucket wheels and intermediates needed in each stage correspondingly reduced, with an increase in efficiency; also since the mean velocity of the jet relative to the buckets is much lower, the loss of energy by friction on the buckets and guide blades is reduced. The frictional loss in the nozzles is slightly increased, but this is of trifling importance. As the expansion is divided into several stages, it is possible to clear each wheel chamber of the water of condensation of the preceding expansion, and as most of the frictional resistance is caused by the entrained moisture in the steam, it reduces greatly the loss due to this cause. Here it may be added that it is good practice to use wheels of large diameter so that a high peripheral velocity can be maintained with safety, with the result that fewer need be employed; which, of course, also reduces the frictional resistance.

In both the Curtis and Rateau turbines, the difference in pressure between the first and the last set of moving vanes is small, consequently the tendency to leak is also small, so that it is possible to have comparatively large clearance spaces between the stationary and moving parts. In the Parsons turbine, the area through the buckets is gradually increased as the volume of the medium increases, while the velocity remains practically constant. In the Curtis turbine the main regulation is secured by changing the number of nozzles in operation, and the finer regulation by throttling a pair of nozzles. This is accomplished by electromagnetic control of small auxiliary valves which admit steam to small cylinders which in turn move the main nozzle throttles. Since for a constant efficiency the rate of expansion must remain constant, it follows that as the pressure in the condenser cannot be made less than a certain value it is necessary to resort to some means of regulating the amount of energy supplied, other than that of throttling the steam; and the reason that the impulse turbine gives such good economy on light loads is because regulation can be secured by changing the number of nozzles in operation. Also, since the entire circumference of the wheel need not be employed, it is possible to obtain the necessary increased area through the buckets by increasing the active arc of the circumference, thus avoiding the necessity of increasing the diameter of the wheels beyond practicable limits. In the Rateau turbine, regulation is secured by the use of an independent governor, which is a slight modification of the well-known Dennis water-wheel governor, which is driven from the turbine shaft by a belt.

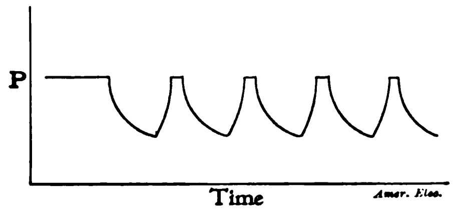

FIG. 2.

The De Laval turbine is the oldest and simplest of all turbines, and the Curtis and Rateau machines are merely special forms of the same type. In the De Laval turbine there is but one set of nozzles and one set of revolving buckets. As has been already pointed out, for maximum efficiency the peripheral velocity of a single-wheel turbine would have to be from twenty to thirty miles a minute, which, of course, would be impracticable, though in the larger sizes of De Laval turbines the peripheral velocity is over nine miles a minute, with a corresponding speed of from twenty-five to nine thousand revolutions per minute. This is reduced by a pair of ten-to-one gears; they are spiral gears cut at opposite angles, being equivalent to a herringbone gear arrangement. The larger one is made of a special bronze, the smaller one being cut directly on the turbine shaft. They are enclosed and run in oil and have been found to give but little trouble in operation, but are very costly and constitute the most voluminous portion of the turbine.

A unique feature of this turbine is the method of mounting the turbine wheel. Running at the enormous speeds at which it is operated, the strain consequent to the centrifugal forces of slightly unbalanced wheels would soon destroy ordinary bearings. To avoid this, the wheel is mounted on a long flexible shaft supported at its ends, thus permitting the wheel to revolve practically about its center of gravity. All strains are thus eliminated, and vibration practically disappears.

The De Laval turbine is governed in much the same way as the Curtis, except that it is not electrically controlled and also that the nozzle control is not automatic. The nozzles must be shut off by hand when the unit is being operated under light load for any considerable period, as the governor, which is of the fly-ball type, merely throttles the steam.

The losses in the turbine, as in all machines, may be divided into two classes—the inevitable and those which may be reduced by improvement in design and construction. It is therefore well to separate them in considering turbine construction. Taking up the various sources of loss in the turbine in the order that they appear in passing from the supply main to the exhaust, the first part to be considered is the nozzle. Here there cannot be any considerable thermal loss as the area from which radiation can take place is extremely small in comparison to the heat energy of the medium passing through it in a unit of time. Nevertheless, losses occur here due to the friction of the fluid on the sides of the orifice, and, owing to the reduced sectional area of the nozzle in comparison with that of the main supply pipe, eddies are formed which materially reduce the velocity of the jet. The greatest loss here is caused by incomplete expansion of the medium in the nozzle as it is impossible to reduce the final pressure below a certain value for practical reasons. Next in order, as the working fluid passes through the turbine, it passes through the buckets. Since the buckets or vanes are constantly passing the nozzles, the jet must enter and leave the vanes from either the top or the sides; hence there will be an unavoidable loss here, which is considerable.[*] In passing through the buckets, losses occur due to friction and on account of the formation of eddies. The first cannot be reduced to any great extent, but the second can be reduced very materially, the best shape for the buckets being determined experimentally. For the reaction type of turbine the cross-section of the buckets should be parabolic, and for the impulse type, circular. In both cases, the edges of the buckets should be tangent to the direction of the jet.

Radiation from the turbine case may be reduced to a small value by proper lagging, and in any case, is not very large when the large quantity of heat stored in the fluid is considered. The heat loss by radiation can be so easily determined that formulas for it are practically useless.

One of the most serious losses of energy is caused by the friction of the gas or vapor on the moving surface of the bucket wheels. This is in a great measure unavoidable, though in the case of vapors it can be greatly reduced by draining off the liquid which collects during expansion. One of the most important arguments in favor of the impulse turbine is the fact that the chambers can be drained, while with the reaction type this cannot be done. The loss on the buckets and guide blades will be also materially diminished for the same reason.[§]

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[*] The formula for the efficiency of a Pelton wheel may be used for this case:

$$E = \frac{[\mu V_1 \cos \phi - \mu^2 - \mu V_2 \cos \Theta]}{V_1^2}$$

in which ϕ is the angle of entrance, Θ the angle of exit, V_1 the initial velocity, V_2 the final velocity, and μ is the circumferential velocity of the buckets. The reduction of efficiency due to this cause cannot be made less than about 10 per cent. As the components of the initial and final velocities of the jet parallel to the direction of the buckets are less than if the nozzle did not make an angle with the line of motion, there will be one value of the bucket velocity which will make the formula a maximum, and this, of course, will be the proper velocity at which the vanes should move. This value can be found from the relation:

$$\mu = \frac{1}{2}\left(V_1 \cos \phi - V_2 \cos \Theta \right)$$

[§] A formula for frictional loss of this kind, which is based on theory, but contains constants to be determined by experiment, is given herewith. It will serve as a guide to anyone wishing to determine this value experimentally.

$$P_w = \frac{(2\pi)^{n+2} V^{n+1} R^{n+3}}{n+3} K$$

In this formula P_w is the frictional loss in foot-pounds per minute; the exponent n and the constant K, must be found for each gas and vapor for which it is to be applied. It is probable that the value of n is about 2, though it may have different values for different gases. The value of K depends upon the character of the surface, pressure, gas and percentage of moisture. R is the external diameter of the wheel, and N the revolutions per minute.

The foregoing are practically all the losses characteristic of the turbine, though leakage around the buckets and guide blades in the reaction type of machine may be added. The latter cannot be reduced below a certain limit for the reason that it is necessary to have a clearance space between the stationary and moving parts which has already been made as small as possible. Generally speaking, the direction in which further improvements can be made are really not directly in the turbine itself, but in the method of superheating the vapor used in order to reduce the friction, and in the maintenance of a more perfect vacuum.

The possibility of constructing a turbine in which a perfect gas may be used in place of vapor has been suggested, and many inventors have tried unsuccessfully to solve the problem. A gas expanded adiabatically in a nozzle cannot impart velocity to itself unless there is a difference in pressure between the reservoir and space into which it escapes; merely heating a gas is of no avail unless it is also compressed. That this is true may be seen by examining Fig. 3, which shows the work diagrams for a cycle which could be used in a gas turbine. The gas is first compressed adiabatically from $p_0\ v_0\ T_0$ to $p_1\ v_1\ T_1$; it is then heated at constant pressure to a point $p_2\ v_2\ T_2$. From this point it is again expanded adiabatically in an ideal nozzle to the original pressure p_0. The gas now cools at constant pressure back to its original temperature. Had the gas been expanded adiabatically in a nozzle from the point $p_1\ v_1\ T_1$, the velocity would be:

$$V = \sqrt{\frac{2g}{w_1}\,\frac{r}{r-1}\,p_1\left(\frac{T_1-T_0}{T_1}\right)}$$

and the work that this jet could do would merely equal the work done in compressing the gas. If, however, the cycle described above be carried through the velocity would be:

$$V = \sqrt{\frac{2g}{w_1}\,\frac{r}{r-1}\,p_1\left[\frac{T_2}{T_1}\,\frac{T_2-T_8}{T_2}\right]}$$

Subtracting the square of the first expression from the square of the second, multiplying by the weight of the gas (taken at one pound throughout this article), and dividing the result by $2g$, there results:

$$P = \frac{1}{r-1}\,R\,\frac{(T_2-T_1)\ (T_1-T_0)}{T_1}$$

which is the rate of work in foot pounds per second that the jet can perform over and above the work of compression. Therefore, the efficiency of the cycle will be:

$$E = \frac{\dfrac{r}{r-1}\,R\,\dfrac{(T_2-T_1)\ (T_1-T_0)}{T_1}}{J\,C_p\ (T_2-T_1)} = \frac{T_1-T_2}{T_1}$$

This result shows, as might be expected, that Carnot's cycle applies as well to the gas turbine as to the gas engine, and that the theoretical efficiency is dependent solely upon the amount of compression.

It is of interest to consider the various methods of heating the gas and to ascertain which of them is the most economical. Upon examinaion it is found that there are five practical methods. In three of them the gas is passed over a heated surface, the fuel used being either oil, gas or coal. In these systems at least 20 per cent of the total heat of the fuel goes up the stack in the products of combustion; but on the other hand all have the advantage of being simple. However, unless care is taken, the apparatus may be damaged by overheating, as the temperatures are necessarily very high. In the other two methods oil or gas is burned in compressed air and the hot products of combustion used in the turbine. This method has been patented by Dr. C. E. Lucke and has the advantages of being the simplest and most economical method of heating air for such a purpose. The only loss of heat is by radiation from the chamber in which combustion takes place; the combustion of the fuel is perfect, and the danger of burning the apparatus is almost eliminated as the fire-pot is lined with a heavy coating of fire clay. The apparatus consists of an iron pot half filled with broken fire brick or crucibles, into which the air and oil are led through a pipe entering the pot a quarter of the way from the bottom. The air and oil are mixed in explosive proportions, the flame cap being broken up by the pieces of crucible. The writer has experimented with this method of heating air for compressed-air engines, and found no trouble whatever in regulating the temperature of the products of combustion. For a large part of the time the temperature of the escaping gases was so great that the outlet pipe was at a bright red heat. The combustion chamber was under a pressure of 120 pounds per square inch; under which conditions perfect combustion was obtained.

Another method which is used is that of compressing the air enough to produce a temperature which is sufficient to ignite the oil. This has the advantage that the oil and air supply can be more easily controlled and the combustion can take place directly behind the nozzle. A great number of cycles are possible besides those here mentioned, such as an explosive cycle which would obviate the necessity of a separate air compressor, but this is difficult to carry out as the necessary apparatus is too complicated for practical purposes.

The great difficulty with the gas turbine at present is that as it is necessary to compress the air or other gas used, a compressor must be used which would have to be driven either from the main turbine shaft or by a separate engine; also with the first-mentioned arrangement, a small independent compressor would be required to start the turbine. As these auxiliary appliances have a comparatively low efficiency, the gains resulting from the use of a gas internally heated would be reduced. This loss in economy is very considerable and may prevent the wide introduction of the gas turbine until it is considerably reduced. On the other hand, the frictional resistance of a gas is less than that of a wet or saturated vapor, in which condition the vapor is likely to be as it requires a large amount of superheat to entirely prevent condensation during the adiabatic expansion in the nozzle. The initial velocity of the jet for a given efficiency of the cycle is much less for a perfect gas than for a vapor, but the volume of the turbine must be larger for gas than for vapor. This is on account of the fact that the quantity of heat transformed into work by adiabatic expansion per degree of temperature range per unit weight of the medium is much less for perfect gases than for vapors. On account of the fact that high temperatures can be easily and safely employed, resulting in a greater amount of the total heat supplied being turned into useful work, it would appear that the gas turbine would furnish a good field for the efforts of the inventor, and it is probable that the room for improvement over the steam turbine by the use of the gas turbine is as great as the possibilities of the gas engine over the steam engine.

In closing, the writer wishes to state that in the foregoing treatment of the turbine problem no attempt was made to give practical formulas for the design of turbines. The only object was to present in as simple a form as possible the theoretical formulas of mechanics and thermodynamics upon which investigations in regard to the turbine must be based in order to obtain useful and reliable results. Experiment has shown, however, that if the nozzles are properly constructed, the velocity as well as the weight discharged per unit nozzle area, as given by the theoretical formulas, may be used without any correction. The efficiency of a well-designed turbine should be from 50 to 65 per cent. By the aid of this data and the formulas given, the nozzle area and proportions, as well as the bucket velocity, may be predetermined with sufficient accuracy for practical purposes.

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A New Process for Electrogalvanizing.—A new process for electrogalvanizing has been discovered by Ignaz Szirmay, of Budapest, Austria, consisting essentially of adding grape sugar (dextrose) to a bath. He says that a pure, glossy deposit of zinc is obtained free from blisters, and adhere so tenaciously that the object may be bent without the coating peeling off. His method is as follows, viz.: 28 pounds of sulphate of zinc are dissolved in 25 gallons of water, preferably warm. Next dissolve separately in boiling water 1½ pounds of sulphate of aluminum, 12 ounces of sulphate of magnesium (Epsom salts) and 6½ pounds of grape sugar. These solutions are then added to the sulphate of zinc solution. The resulting solution should be clear, and have a feeble acid reaction. An anode of pure rolled zinc is recommended. The deposition is carried out at about 65° Fahrenheit with a current of 10 amperes per square foot, and a voltage of four volts. In order to prevent bubbles of hydrogen gas from adhering to the work, it is kept in motion. This also serves to stir up the solution and keep it uniform.—*Exchange.*

Northwestern Electrical Convention

The annual convention of the Northwestern Electrical Association was held this year as usual at the Hotel Pfister in Milwaukee, on January 20 and 21. After disposing of some routine business on Wednesday, the convention opened with an address, by President F. W. Bowen, of Kenosha, Wis. He gave credit to Secretary Mercein for whatever success the present convention might attain, as the secretary was responsible for the programme this year. One feature which he had hoped to make prominent at this convention was a "question box" and "wrinkle department," upon which he had intended to do some personal work during the past year but had been prevented by the burning down of his central station twice during that period, which interfered with his work for the association. Mr. Bowen did not favor the pre-arranged discussion of papers, being of the opinion that many members, if not stifled by an air of pre-arrangement in the programme, would feel free to discuss papers and bring out many obscure points that would otherwise escape attention. The twin subjects of taxation and municipal ownership were, he said, always with us, but he was of the opinion that in future both were more likely to be met in a spirit of fairness than they have been in the past. He had no recommendations in the nature of a "cure-all" to make, but said that when the nature and hazards of the electrical business were more understood by the general public, the fraternity would be better treated by the same public through their chosen representatives. The president's address was followed by the reading of the paper on "Central Station Heating" by W. H. Schott.

In response to questions as to cost of coal per year in a fairly efficient heating plant, Mr. Schott cited a test recently made by Prof. Goss at Purdue University. Using these tests as a basis, with coal at $2 per ton containing about 10,500 B. T. U. per pound, the coal would cost about 8 cents per square foot of radiating surface per season in a hot-water heating system. He thought about 70 pounds of coal per square foot of radiation per season a safe basis on which to figure. With a steam-heating system about 130 pounds of coal per square foot per season is required with automatic temperature regulation. Without this regulation the amount would run as high as 180 pounds.

Mr. Kimball stated that in Kenosha, where an attempt had been made to separate the charges due to electric lighting and heating, it was found that about 77 pounds of coal per square foot of radiation was required in addition to the exhaust steam which was put into heating. This was based on coal having 12,500 B. T. U. per pound.

Mr. Schott said that in the Purdue test everything was charged against the heating plant except the efficiency of the engines and pumps. The engines absorbed 7 per cent of the heat transmitted to them and the pumps 4 per cent. The former took 28½ pounds of water per indicated horse-power hour, and the latter 95½ pounds. In response to a question as to the difference in cost of furnishing heat with and without automatic temperature regulation Mr. Schott said that tests had shown the cost to be about 40 per cent more for heating without automatic regulation than with it. In this figure, labor, fuel and everything were taken into account. Mr. Kimball did not agree to the statement that the difference between cost of supply with and without automatic regulators was as much as 40 per cent. Mr. Almert, of Chicago, inquired of Mr. Schott whether he did not find that in most plants the figures he gave on coal consumption were not double, owing to engineering deficiencies. Mr. Schott thought it was double for old-time plants.

When asked whether he had formulated any figures upon a town's consumption of coal per annum per foot of radiation, Mr. Schott said that in a well-designed plant situated in a place where the temperature averages 30°, as in Central Illinois and Indiana, when using Illinois slack coal, the consumption should not exceed 70 pounds per square foot per season. The actual figures are 63 pounds, but 70 pounds should be allowed so as to cover losses. In the Purdue tests, where they arrived at a 77-pound basis with coal having a calorific value of 10,500 B. T. U., they obtained in the boilers only a fraction over 4000 B. T. U. per pound. This was because (1) the boilers did not have a proper circulation through them, (2) the fire was being controlled by the ash-pit doors instead of by the damper, (3) the boilers had not been cleaned in six months, and 5 feet of the lower tubes were banked in with soot and ashes. These drawbacks were discovered soon after the tests. Replying to the question as to the B. T. U. radiated per hour per square foot, Mr. Schott said that if a temperature of 200° was maintained not less than 246 B. T. U. would radiate per square foot per hour; at 170°, 170 B. T. U.; at 160°, 155 B. T. U.

Mr. Almert asked what the temperature ought to be in the out-going and return pipe for average conditions, and Mr. Schott said that depended upon how fully the system was loaded. A 20° maximum drop would be a fair average with a 30° difference between supply and return at the power house. In replying to a question by Mr. Kimball, Mr. Schott said he did not think it good practice to sell hot water for domestic purposes unless the company received a high price for it. Mr. Harding said in his plant there had been some stealing of hot water for domestic purposes by customers; but since they put in meters they kept a very close tab on leakages. Mr. Schott favored a supply of hot water for domestic uses by placing hot water coils connected with the mains in ranges, boilers or tanks, thus heating the water in the customer's tank by the circulation water rather than have him draw the circulation water out of the system itself. Replying to a question regarding the quick location of leaks, he said that a leak is made known in fifteen seconds with a balanced column system. His practice had been to let the customer furnish his own water; in Little Rock, however, tne city water was very bad, and an ordinance permitted their furnishing water for domestic purposes. In that case, however, the water was purified before it was put into the hot water system. With pipe lines tested to 120 pounds pressure, there was no need of worrying very much about the leakage with expansion joints every 300 feet. Leakage was found in old plants where expansion was not provided for.

The president asked Mr. Schott about how many square feet of radiation he would take care of per horse-power of exhaust steam from an engine with hot water heating. Mr. Schott said that the average during the season would be 17,500 square feet, and at 10 below zero about 10,000 square feet. If a horse-power takes care of over 6800 square feet, it is doing first rate, if the regulation is properly figured.

The president then asked Mr. Schott what would be the relative horse-power required in a building for heating and lighting, or, how near heating and lighting would balance. Mr. Schott said this depended on the kind of building. Assuming a store building with the ordinary amount of lighting, there will be a surplus of steam at all times from the lighting engines over and about what would be required for the heating of the building.

Following the discussion of Mr. Schott's paper, Charles R. Underhill, of Providence, R. I., read the paper on "Coil Windings for Electrical Purposes," by Richard Varley and Charles R. Underhill. Following this was a paper by W. Scheidel on the "Electrolytic Rectifier and Interrupter."

The "Smashing Point of Incandescent Lamps" was the subject of a paper by George C. Keech, of Chicago. He referred to the coining of the phrase "smashing point," by Carl Hering ten years ago, as filling an immediate want. This descriptive phrase invited explanation and discussion. In an incredibly short time the idea that 80 per cent of the initial candle-power of the lamp was the limit of its universal life was universally adopted. The next step toward an ideal lamp was to make one which would automatically die when it had lived out its usefulness. Alex. Dow, of the Detroit Edison Company, stated that 90 per cent of customers' complaints could be traced to dim lamps. A customer, he said, should get an average of 90 per cent of the initial candle-power of the lamp. It is agreed that a lamp is useless after it has depreciated 20 per cent, and although almost everyone realizes that it is economy to remove a lamp at this point, very few practice it; hence, the only really economical lamp to use is one that will burn out at or near its smashing point.

A discussion then followed as to the policy of buying 3.5-watt lamps and operating them at about 3 per cent above rated voltage as against buying 3.1-watt lamps and working them at their rated voltage. From this discussion it appeared that the efficiency and life of the lamps in these two cases would be about the same, but a 3.5-watt lamp at 3 per cent above normal voltage would give about 19 candle-power instead of 16. Some thought it would be better to buy a 20-candle-power lamp of 3.1 watts efficiency rather than operate the 3.5-watt lamp so as to make a 19 or 20-candle-power lamp of it. In response to an inquiry, Mr. Keech said, from a manufacturer's standpoint, the consumer would get a closer selection on a 3.1-watt lamp than on a 3.5-watt lamp. Mr. Harding said for a number of years he had followed the plan of running his lamps 2 volts high during the important lighting hours of the evening, going back to normal voltage (108 volts) about 10:30 p. m., and maintaining it for the balance of the twenty-four hours, until the lighting load came on the next afternoon.

When the convention was called to order Thursday morning, a paper by W. L. Waters on "Double-Current Generators" was read and discussed, the discussion serving simply to bring out the same points that were mentioned in the paper.

A paper on "Rectifiers" by Prof. C. F. Burgess, of Madison, Wis., was then read. Although known for fifty years, it is only recently that the electrolytic rectifier or electrolytic valve has been placed on the market. Fifty years ago it was found that aluminum in certain solutions opposes the passage of the current from it to an electrolyte and of freely altering its passage in the opposite direction. There are many solutions which, in contact with aluminum allow this electrolytic action to become manifest. Some are more efficient than others. It is only recently that improvements have brought the working efficiency of the apparatus up to a point where it can be used commercially. It is not yet all that can be desired, for certain classes of work, such as charging small storage-battery equipments, it offers advantages. One limitation is that a single cell cannot be used with a pressure much over 50 to 60 volts; cells must be placed in series where higher pressures are necessary. An efficiency of between 50 and 60 per cent was showed by tests in the Wisconsin University laboratories and this efficiency is practically constant regardless of the size. Another limitation of the rectifier is that pulsations of the current, while interfering in no way with its use for charging batteries, may produce a humming sound and heating by eddy currents motors operated by such current, and also a humming sound in telephone lines operated from batteries which are being charged by this pulsating current. Because of the pulsating nature of the current obtained from such a rectifier it is not possible to correctly measure it with direct-current instruments. Electrolytic rectifiers may be subdivided into two classes. In one an aqueous electrolyte is supplied; in another, a non-aqueous or fused electrolyte.

Mr. Carl Hambuechen, of the University of Wisconsin, has discovered that aluminum acts most efficiently as an asymmetric conductor when placed in moulten sodium nitrate or similar salts. Upon this discovery is based the second class of electrolytic conductors which employs the fused electrolyte. An average efficiency of from 10 to 30 per cent higher than that of the aqueuous solution may be maintained with the sodium salt on account of the more efficient valve action of the aluminum and the lower resistance of the electrolyte. It has a further advantage in that the development of heat is utilized in keeping the material in a state of fusion and at a high degree of activity. With the aqueous type, the elevation of temperature beyond thirty or forty degrees Centigrade causes such a rapid decrease in efficiency that artificial means are necessary for dissipating heat. One of the essential parts of this rectifier consists in a special wound transformer which allows connection to a 110-volt or other convenient source of alternating-current supply. This transformer has various terminals by means of which the ratio of transformation may be regulated. Connections are made also from the windings of the transformer to two aluminum electrodes and an iron electrode. The electrodes are contained in an aluminum case surrounded by an asbestos cover passing through and being held in place by a stone top. When the rectifier is not in use the electrolyte is perfectly solid and non-conductive. By passing a low-voltage high-volume alternating current lengthwise through the iron electrode for four or five minutes, the cell is brought into working condition, after which the heating current is switched off and the cell is maintained at the desired working condition by the natural heat losses when operating within 25 per cent of the normal load. In the aluminum electrodes 1/8 in. x 1 in. x 2 in., the normal load is 10 amperes at a rectified pressure of from 25 to 30 volts. The current may be several hundred per cent higher than this value for a short time without detriment, and a 50 per cent overload causes excessive heating and evaporation of the salt only after several hours' run. The total weight of apparatus for an output of this capacity is about 30 pounds, most of which is in the transformer. All the attention which the device requires is the addition once in each day of operation of a small amount of salt through an opening in a stone cover. This salt is added for the purpose of supplying losses of the electrolyte by vaporization and neutralizing the tendency of the electrolyte to become alkaline by the decomposing effect of the current. While thus maintaining the salt in working condition, aluminum electrodes have been operated for over 800 hours without excessive corrosion, and the iron electrodes last a considerably longer time. Estimates of the cost of the additional salt and the renewal of electrodes place the figures at below 3/10 of a cent per kilowatt-hour.

A considerable rambling discussion followed this paper, and it seemed to be the opinion of the central station men present that it might open up a new field for their alternating-current output.

Mr. Cutter suggested that the efficiency of a small motor-dynamo set for automobile charging was not over 60 per cent and it was much more cumbersome and costly than an electrolytic interrupter. It was also suggested by Mr. Lansingh that the light weight of this rectifying apparatus would permit of its being carried by an automobile, so that charging could be done anywhere that alternating current could be obtained.

The report of the nominating committee was then presented, and the following officers were elected for the ensuing year: T. F. Grover, Fond du Lac, Wis., president; George H. Lukes, Evanston, Ill., first vice-president; E. A. Daniell, Menominee, Wis., second vice-president; Thomas R. Mercein, Milwaukee, secretary and treasurer; W. H. Schott, Chicago, D. C. Jackson, Madison, Harold Almert, Oak Park, Ill., directors. It was voted to hold a meeting in St. Louis in September in conjunction with the other electrical organizations who hold meetings there at that time. The morning session then adjourned.

On Thursday afternoon, a paper on "Standard Practice in the Use of Alternating-Current Electrical Apparatus," by J. J. Gibson, was read. This was an extended review of the subject indicated in the title. The discussion of this paper was limited, as the author was not present.

A paper by J. M. S. Waring on "Storage Batteries for Small Central Stations," was then read. After his paper Mr. Waring showed a number of lantern slides illustrating various points in connection with storage battery installations. Some of these slides showed a plate known as the "box negative," which was introduced about a year ago by the Electric Storage Battery Company and has superceded the former type. The pellets of active material are held in place by a perforated lead sheet on each side of the plate, to prevent the loss of active material. He explained that with this type of negative, blistering which might make contact with positive to negative was prevented, and this did away with the necessity of probing the cells to knock the blisters off. There was then some discussion as to the value of a storage battery auxiliary in a small central station supplying a small electric railway where the load is always extremely fluctuating. Mr. Waring cited tests by a firm of consulting engineers in Chicago at the substations of an interurban railway. Without the battery fluctuations of voltage were 16 per cent as against 3 per cent with the battery.

The battery in use by the Milwaukee Electric Railway & Light Company in its central station was cited. This consists of two 550-volt batteries, either one of which can be used on the railway or can be divided up to operate on the three-wire Edison lighting net-work. Ordinarily one battery is used floating on the railway bus bars, and the other is floating on the lighting bus bars. In case of a break-down on either system, both batteries are put on the system needing the help.

A paper by James Lyman, of Chicago, on "Steam Turbines," was then read, but the lateness of the hour did not permit of discussion, and the convention listened to a lecture by Prof. R. A. Milliken, of the University of Chicago, on "Radium."

Abstracts from Foreign Contemporaries

Ferranti Alternating-Current Integrating Wattmeter.—A new alternating-current wattmeter possessing certain novel features has recently been introduced by Messrs. Ferranti, Limited. The meter, which is described in the London *Electrician*, is of the induction-motor type, measuring the energy consumed on an alternating-current circuit, whether the load is inductive or non-inductive. The accompanying illustrations show clearly the construction of the meter, and indicate the simplicity of its parts. The aluminum rotatable disc *D*, mounted on the spindle *S* and geared to the train of wheels *CT* actuating the index hands, serves the double purpose of an armature receiving the driving torque of the meter coils and also the retarding torque of the permanent magnets *PM*. One shunt coil, *ShC*, placed round the coil *C* of a special tubular electromagnet, *TM*, constitutes the shunt system. The core of this magnet has three outward radial poles, P^2, alternating with four inward radial poles, P^1, from the shell or tube of the shunt magnet, the plane of these poles being horizontal and parallel to the disc; this tubular magnet is placed below the disc. The series system consists of a slotted armature, *SA*, above the disc, the series coil *SeC* being wound in these slots. A wave-form of winding is used, somewhat similar to the winding adopted by Mr. Ferranti for his alternators in 1884; it will be noted that the slots of the series armatures are almost directly above the poles of the tubular magnets. If the shunt circuit be sufficiently inductive, the eddy currents produced in the disc by the shunt field will be in phase with the impressed e.m.f. These eddy currents are acted on by the series field, which is in phase with the load current, giving a driving torque on the disc proportional to the e.m.f. of the circuit multiplied by the amperes and by the cosine of the angle of lag of the main current behind the e.m.f., this being the true watts supplied to the circuit through the meter. The retarding torque due to the permanent magnets is proportional to the speed, and the disc therefore revolves with a speed which is proportional to the watts.

The meter can be calibrated by slightly altering the relative positions of the shunt and series magnets, by means of the two screws S^1 and S^2. The driving torque of the shunt alone, even with the maximum possible displacement of the series armature, is extremely small, and as it will be noted that the armature is fixed by a powerful clamp, *Cl*, and the two screws S^1 and S^2, the possibility of the meter developing any tendency to creep on the shunt is very remote. The constant of the meter is also readily adjusted by lowering or raising the series armature by means of the nut *N* on the threaded spindle *TS*, the effect of this being to strengthen or weaken the action of the coils, and after adjustment the series magnet is securely fixed by means of the strong clamp *Cl* and the screw S^3. On all conditions of circuit, inductive or non-conductive, on overloads up to 50 per cent and under variations of voltage to 50 per cent above or below the normal, the meter is claimed to be very accurate, and practically independent of variations in frequency, wave form or temperature. The meters are fitted with removable jewelled brass settings, *J*, which enables a defective jewel to be easily replaced by a new one at any time without altering the calibration of the meter, all parts being interchangeable.

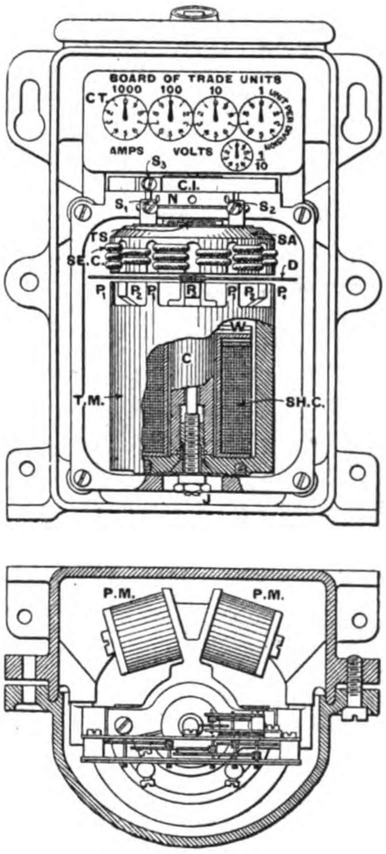


FIG. I.

The Economy of Superheated Steam.—In a paper on this subject read by Mr. E. A. Reynolds before the Rugby Engineering Society, the author said that the principal object of superheating steam is to prevent, or, at any rate, reduce, transfer of heat, and to prevent initial condensation; for although the steam gives up some of its heat to the metal on admission, there is no condensation, the only effect being a reduction of volume and a fall in temperature. The relation between pressure, temperature and volume is given by the equation $PV = 93.5T - 91P^{\frac{1}{4}}$, where *P* is measured in pounds per square foot absolute, *V* is the volume in cubic feet of one pound of steam, *T* is the absolute temperature in degrees Fahrenheit. On putting *T* equal to the temperature of saturated steam, this formula gives very closely the volume corresponding to different pressures. On calculating *V* for various temperatures of superheat, it will be seen that at 300° Fahrenheit of superheat the volume of the steam is increased by about 50 per cent. Owing to this increase of volume superheated steam requires a less quantity of heat to produce a certain volume than saturated steam at the same pressure, so that by using superheated steam less heat enters the cylinder at each stroke than when saturated steam is used; and as the same amount of heat is converted into work in each case, this shows where the economy of superheat lies. It has been found that to obtain a certain velocity of steam in a pipe, superheated steam requires a smaller drop in pressure than saturated steam; for this reason the steam pipes may be made smaller, thus giving a higher velocity, and yet keeping the pressure drop the same. With superheated steam the amount required for a given power is less than with saturated steam, and the pipes may be made still smaller. Another advantage is that separators are unnecessary; the absence of water in the steam mains also does away with all risk of getting water into the cylinders through priming. A test tthe author made a short time ago on a small simple engine running non-condensing at 65 pounds pressure in the steam chest and a cut-off of 0.3, showed a gain of 35 per cent in weight of steam used by using steam superheated 220° Fahrenheit. The water consumption came out at 20 pounds per i.h.p., which compares favorably with compound engines working as a high steam pressure. In tests of various engines that the author has made, he has found very little difference in the percentage gain with triple or compound expansion, the compound showing a little more than the triple. The gain obtained is about 15 per cent at 100° Fahrenheit superheat, 20 to 21 per cent at 150° Fahrenheit, and 23 to 25 per cent at 200° Fahrenheit, measured in weight of water used. The gain, of course, varies with the point of cut-off, and the ratio of expansion. In each case the temperature was measured outside the throttle valve. In a trial

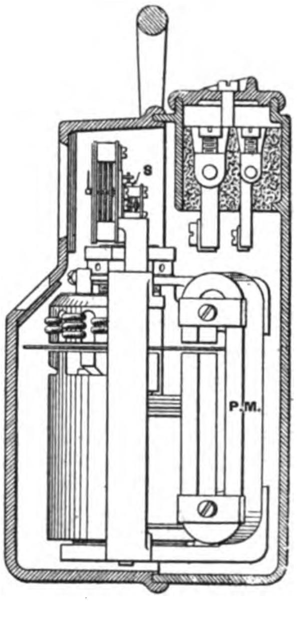


FIG. 2.

on a triple engine, when the temperature was measured inside the steam chest, the percentage gain curve came out exactly a straight line up to 180° Fahrenheit superheat. There is little gain due to superheating in any cylinder after the stage is reached in which the steam is kept dry throughout the whole expansion, and the only object of taking the superheat higher is to obtain dry steam as far as possible during the whole expansion in the engine. The same effect, however, would be obtained by reheating the steam in the receivers between the different cylinders, so that it enters each cylinder superheated sufficiently to ensure it being dry at the end of the expansion in that cylinder. This is most easily effected by passing the superheated steam through coils in the receivers on its way to the steam chest of the engine, so that it may give up some of its superheat to the steam that has already expanded in the previous cylinder, and then pass to the steam chest at a lower degree of superheat. The utility of this method is that in which the steam is kept dry throughout the whole expansion, and the only object of taking the superheat higher is to obtain dry steam as far as possible during the whole expansion in the engine. The same effect, however, would be obtained by reheating the steam in the receivers between the different cylinders, so that it enters each cylinder superheated sufficiently to ensure it being dry at the end of the expansion in that cylinder. This is most easily effected by passing the superheated steam through coils in the receivers on its way to the steam chest of the engine, so that it may give up some of its superheat to the steam that has already expanded in the previous cylinder, and then pass to the steam chest at a lower degree of superheat. The utility of this method is that although we get the advantage of a high degree of superheat we do not get the disadvantage of a high temperature in the engine. With the use of high superheat temperatures there are, of course, large internal stresses due to the unequal expansion of different parts of the body of the engine. For this reason it would seem best to have the cylinders separate and perfectly cylindrical externally, and valve boxes and other parts to be firmly bolted on with heavy flanges when these are necessarily outside the cylinder.

Aron Two Rate Meter.—E. S. Shoults describes in a recent issue of the London *Electrical Review* the Aron two-rate meter shown by Fig. 3 herewith. To the left of the meter is shown an ordinary clock, which is electrically wound, having two extra dials on the top, one of which makes a revolution once in twenty-four hours and the other showing seconds. The first is necessary owing to the fact that the clock having only a twelve hour dial no distinction is made between day and night. The second is provided so that the regulation of a large number of the clocks can be carried out in as short a time as possible. Underneath the clock itself are two more dials with twenty-four divisions giving the twelve hours for day and night respectively. These dials are provided with pointers which can be revolved counterclockwise and so set at any hour by hand, the pointer on the left dial generally representing the beginning, and that on the right the end of the high rate period. By this means the twenty-four hours can be divided into two parts, the shorter one generally corresponding to the peak when the charge per unit is a maximum, and the longer one to the period during which the charge is greatly reduced. The distinction between day and night is made by the black and white colors of the dial centers. On the right hand side is the meter. This is a regular Aron meter except that the dials are placed in a vertical row, and an extra set is provided so that by means of the change-over gear fitted at the bottom of the dials, the record will be made alternately on the left and on the right set of dials according to the setting of the two pointers underneath the clock dial. An indicator on the meter side shows which set of dials is in use, the whole arrangement being visible through the windows.

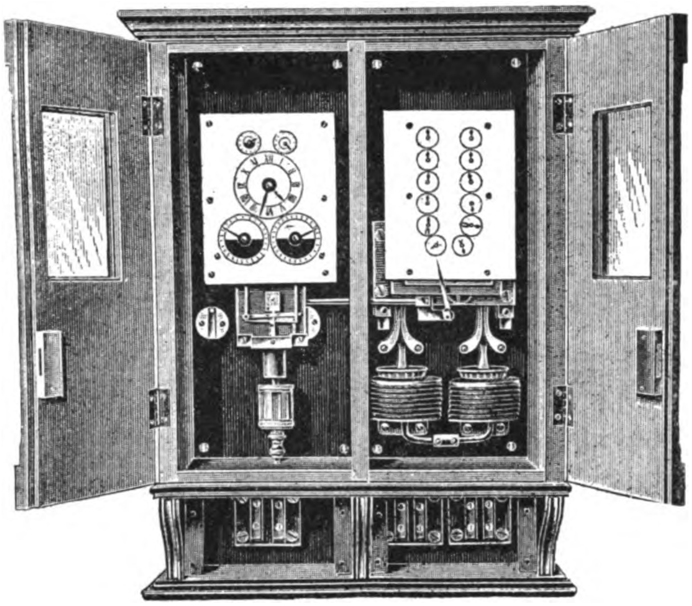


FIG. 3.

Combined Stop and Isolating Valve.—Figs. 4 and 5 herewith, taken from *Engineering* of London, show a valve the chief feature of which consists in its closing automatically in both directions in case of accident. If a tube should burst in a water-tube boiler, for instance, the valve automatically closes and prevents any escape of steam from the boilers at work through the defective boiler. The valve also acts as an ordinary stop valve. Another feature of the valve is that it automatically connects the boiler in which steam is being raised with the boilers at work and under full steam. The steam pressure on the outlet or upper side of the valve keeps it closed until the pressure in the boiler being set to work is sufficient to open it. Boiler attendants are at times deceived by inaccurate steam-gauges, and are liable to turn on steam and connect the boiler when there is a considerable difference in pressure. Many accidents have resulted from this cause. The horizontal

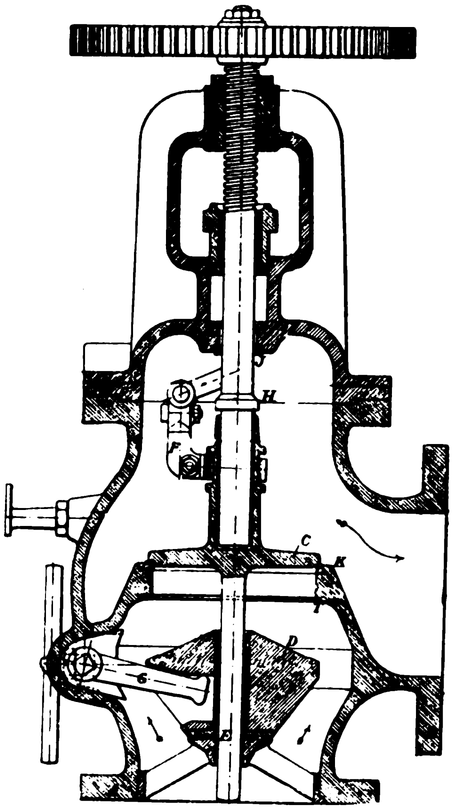


FIG. 4.

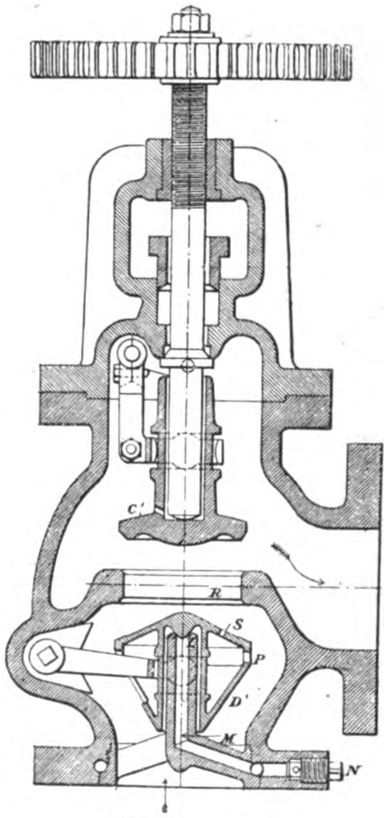


FIG. 5.

flange *A* is connected to the boiler, and the vertical flange *B* to the steam-pipes. The arrows indicate the direction of the flow of steam. The combined valve consists of two separate valves—the upper valve *C* and the lower valve *D*, both being loose on the spindle. When the valve *C* is screwed down, it acts as an ordinary stop-valve and shuts off the boiler; and when the spindle is raised, the valve is opened by the flow of steam from the boiler, when the pressure on both sides is equal. The valve *C*, being loose on the spindle, acts as a non-return valve, and immediately closes in case of accident to the boiler, and prevents escape of steam from the other boilers. The lower valve *D* operates in the opposite direction—that is, in case of steam-pipe fractures or any other mishap on the outlet side of the valve. Under normal working conditions this valve is kept in position by its own weight and a certain pressure of steam caused by a partial vacuum formed by the flow of steam past the valve, which exerts a suctional action in the space between the valve and spindle, as indicated by arrows at *E*. The valve can be set to close at any desired difference in pressure by an adjusting screw. When once adjusted, a padlock or seal may be applied to prevent anyone tampering with the valve. When an accident has occurred and the automatic valve *D* is closed against its seat *T*, it is kept in this position by the steam pressure until the stop-valve *C* is closed. When this is done, the steam pressure on both sides of the valve *D* is equalized by a small quantity of steam passing to the upper part of the valve through the space between the valve and spindle; this causes the valve to return to its normal working position. Handwheels for testing are connected by means of spindles to the levers *F* and *G*, and in this way the valves *C* and *D* can be controlled from the outside and kept in working order. A valve facing *H* is formed on the spindle, which, when the steam stop-valve *C* is fully open, comes in contact with the seating *J* immediately under the stuffing-box; this protects the packing, and also admits of new packing being put in while the valve is under full steam.

Fig. 5 illustrates the type of valve used when it is desired to place the valve at an angle or in an inverted position. This valve is in all respects the same as shown in Fig. 4, excepting as regards the design of the isolating valve *D'*. The special object of the arrangement of the isolating valve *D'* is to keep it in position under normal working conditions, quite independent of the position of the stop-valve. For this purpose valve *D'* is provided with a small valve which rests in a seat formed at the top of the hollow guide-spindle *M*, which opens to the atmosphere at *N*. The valve is thus kept in position by direct pressure of steam. In case of accident, the increased velocity of steam, consequent upon the difference of pressure, easily overcomes the pressure required to keep the valve in position under normal conditions, and closes the valve *D'* on the seating *R*. The valve *D'* is kept by the steam pressure against its seating, *R*, and can only be released by shutting the stop-valve *C'*, when steam passing through the small openings *P* and *S* causes an equal pressure on both sides of the valve. The valve *D'* will then return to its seating and resume its normal position. When the valve *D'* closes, due to the occurrence of an accident, this is at once indicated by a small steam jet discharged from the opening *N* into the atmosphere. By adjusting the size of the opening *N*, the isolating valve *D'* may be set to close at any difference in pressure. The valve *C'* acts in a similar way, and is in all respects the same as described in Fig. 4.

SOME RECENT ELECTRICAL PATENTS

Constant-Current Transformer.—It is well known that for transforming alternating currents from constant potential to constant current use has been made of a transformer containing relatively movable primary and secondary windings embracing a common core, the regulation for constant current being obtained by the automatic variations of the inductive relations between the primary and secondary windings due to the repulsion set up by the currents carried by those windings, which forces them apart. This well-known transformer embodies the disadvantage of a low power factor at very light loads. With a view to remedying this disadvantage, the modification of the Thomson transformer shown by Figs. 1 and 2 herewith has been devised by Malcolm H. Baker. This consists of a primary winding, *2*, mounted on a laminated core, *1*, the magnetic circuit of which is not quite closed; a movable secondary winding, 3, adapted to slide over the primary winding and one leg of the core, and a counter-weight, 6. When the movable secondary, 3, is at its lowest position, as shown in Fig. 2, the mutual induction between the two windings is, of course, maximum, and this, therefore, is the full-load position. When in this position, if some of the lamps are cut out on the circuit the current in the secondary winding will, of course, increase, thereby increasing the repulsion between the two windings and causing the secondary winding to rise until equilibrium is again restored. As the winding rises, it interlinks less and less of the magnetic flux passing across the air-gap, so that the secondary voltage becomes less and less; equilibrium is restored when the secondary current falls to normal value. The secondary coil assumes the position in Fig. 1 at no load; that is to say, when all of the translating devices are short-circuited. It is obvious that the power factor of this transformer is higher at no load than it would be if the magnetic circuit were completely closed about both coils; also that it is lower at full load than it would be if the magnetic circuit were completely closed. Patent No. 748,146.

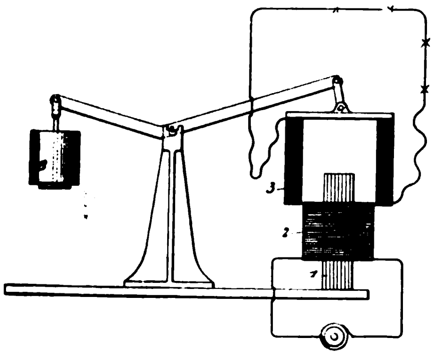


FIG. 1.

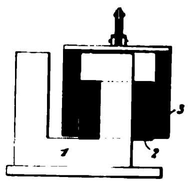


FIG. 2.

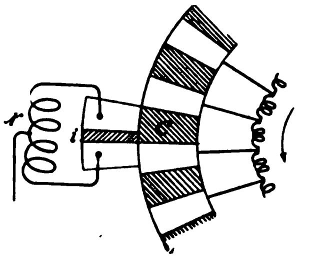


FIG. 3.

Series Alternating-Current Motors.—In order to overcome the tendency to excessive sparking which is characteristic of any series alternating-current motor built along the ordinary lines, Rudolph Ziegenberg has devised and patented the peculiar arrangement illustrated by Figs. 3 to 5, inclusive. This arrangement consists of a double commutator brush, the two parts of which are separated by a relatively thick insulation, *i*, and connected to an inductive winding, *N*, as in Figs. 3 and 4, or to a section of the field winding as in Fig. 5. When connected to the inductive winding, as in Fig. 3, this winding is made the secondary of a small induction coil as illustrated in Fig. 4. The object of this arrangement is to induce a counter electromotive force in the coil undergoing commutation which will neutralize the e.m.f. generated therein by the alternating flux in the armature core—the transformer e.m.f. Referring to Fig. 4, it will be seen that one terminal of the primary winding of the small induction coil, *W*, leads to the middle of the secondary winding, so that the field current passing through the secondary winding does not affect it. In Fig. 5 the e.m.f. applied to the double brush is taken from the main field winding and is equal, of course, to the difference of potential between the two points of the field winding to which the double brush is connected. The object of

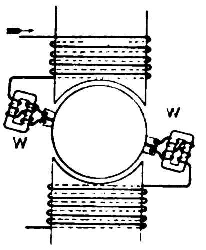


FIG. 4.

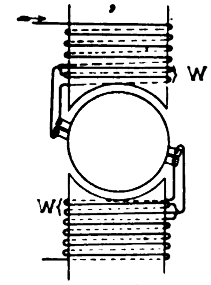


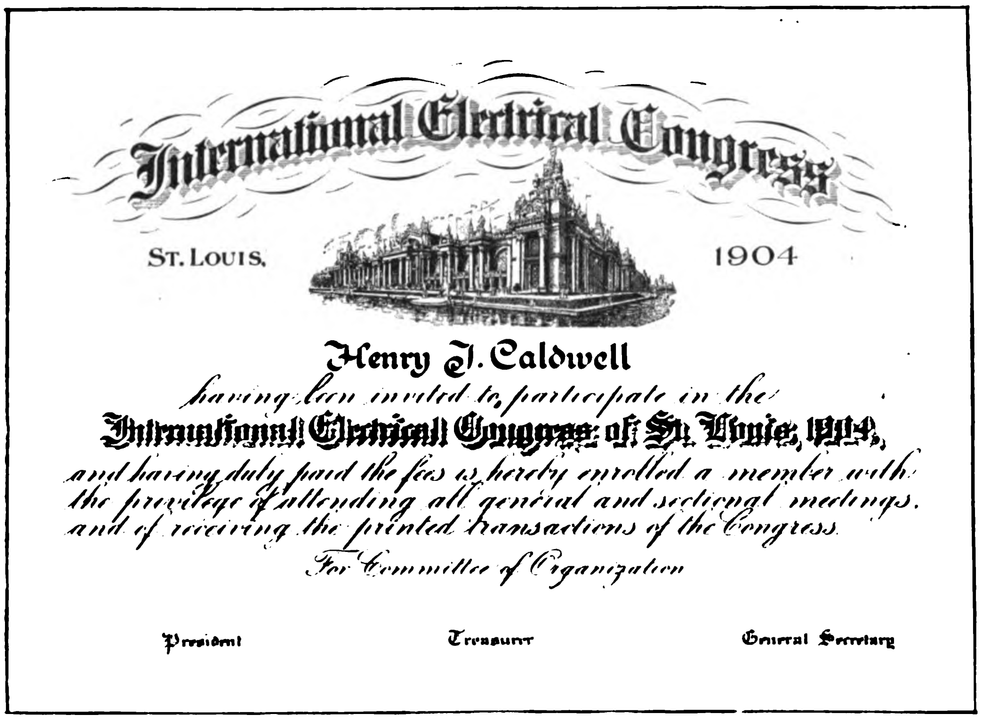
FIG. 5.

the inventor is merely to counteract the e.m.f. induced in the commutated coil by the alternations of the flux in the armature and not to produce what in a direct-current machine would be termed a commutating em.f. In order to prevent either half of the brush from simultaneously touching two commutator segments, the insulation between the commutator segments is made unusually thick, as indicated by the shaded portions, *C*, in Fig. 3. Patent No. 748,907.

◆

THE INTERNATIONAL ELECTRICAL CONGRESS AT ST. LOUIS.

According to the present indications, the International Electrical Congress to be held at St. Louis, September 12 to 17, 1904, will be one of the most successful that has yet been held, both with respect to the number of adhesions and to the value of the transactions. Up to date about 3550 circular letters of invitations to join the Congress have been issued to persons or associations in North America. In response to these nearly 900 acceptances of membership have been received. About 350 similar circular letters of invitation have been recently sent to other countries. It is intended to issue in all about 5000 invitation circular letters in American and about 6000 in foreign countries. Many persons, both in America and abroad, who do not expect to attend the sessions in St. Louis, will probably join the Congress in order to secure a copy of the *Transactions,* which wil form one and perhaps two large actavo volumes. The collection of fees has commenced, and upon receipt of a fee the member will be forwarded a Certificate of Membership, a *fac simile* of which is shown herewith, without the signatures. The full size of the certificate is 8½ in. x 11 in. (21.5 cms. x 28 cms.) and it is printed on heavy paper of excellent quality.



International Electrical Congress

ST. LOUIS, 1904

Henry J. Caldwell

having been invited to participate in the

International Electrical Congress of St. Louis, 1904,

and having duly paid the fees is hereby enrolled a member with the privilege of attending all general and sectional meetings, and of receiving the printed transactions of the Congress.

For Committee of Organization

President Treasurer General Secretary

Special letters of invitation have been issued to prominent electricians and electrical engineers requesting papers for the Congress in the various sections; 146 were sent to foreign authors and 134 to American authors. There has not been time to receive replies from many of the foreign authors, but 21 acceptances have up to date been received from abroad, and 46 acceptances from North America. Sixty-seven papers are thus already promised for the Congress, and the number is steadily increasing. A considerable number of invitations to contribute papers have yet to be issued. It is hoped that the Congress will convene with a full program in each section, and that at least half of the papers may be from foreign countries. According to the plans of the Committee of Organization, papers for the Congress program are specially invited, but papers voluntarily offered will be submitted to the officers of the sections to which the papers belong, and may be included in the program by invitation at their request, if the subjects are desirable, and if the schedule allotted to each section will permit, it being the desire of the section officers to secure and offer the best possible program and presentation.

The following section chairmen and secretaries have been appointed by the President, and have already done much work in organizing their sections:

Section A, General Theory: Prof. E. L. Nichols, Cornell University; Prof. H. T. Barnes, McGill University.

Section B, General Applications: Prof. C. P. Steinmetz, Schenectady; Prof. Samuel Sheldon, Brooklyn.

Section C, Electrochemistry: Prof. H. S. Carhart, University of Michigan; Carl Hering, Philadelphia.

Section D, Electric Power Transmission: Mr. C. F. Scott, Pittsburg; Dr. Louis Bell, Boston.

Section E, Electric Light and Distribution: Mr. J. W. Lieb, Jr., New York; Mr. Gano S. Dunn, New York.

Section F, Electric Transportation: Dr. Louis Duncan, Mass. Inst. Technology; Mr. A. H. Armstrong, Schenectady.

Section G, Electric Communication: Mr. F. W. Jones; Mr. B. Gherardi, New York.

Section H, Electrotherapeutics: Dr. W. J. Morton, New York; Mr. W. J. Jenks, New York.

The Committee of Organization of the Congress consists of Elihu Thomson, President; A. E. Kennelly, General Secretary; W. D. Weaver, Treasurer; Bion J. Arnold, Vice-President and Chairman of Executive Committee; C. F. Scott, Dr. S. W. Stratton, Prof. H. S. Carhart and Prof. W. E. oldsborough, Vice-Presidents.

All communications should be addressed to the General Secretary, Dr. A. E. Kennelly, Harvard University, Cambridge, Mass.

◆

The De Mare Electromagnet.

To the Editor, American Electrician:

Sir:—I do not know to what cause to attribute the errors which have been committed in your comment on my type of electromagnet. (AMERICAN ELECTRICIAN, November, 1903, page 553.) At any rate, the winding, characterized as "freakish," was not inspired by the contemplation of any stator winding whatever; time is too short to dwell on this point at length.

The theory of electromagnets is not violated; there is simply a better utilization of the current. It is only for this reason that I decided to make public this type of winding. For example, two electromagnets may be constructed with the same iron, they may have the same weight, the same cross-section, the same length, the cores may be wound with the same quantity of wire (weight, length, diameter), and these two electromagnets may differ in nothing but the method of winding; under these conditions the electromagnet with the solid core is [only] able to hold a weight ten times smaller than the laminated electromagnet of my system, with equal excitation. This may appear to you extraordinary but it is so, as you can easily find out by making the experiment.

F. DE MARE.

Brussels, Belgium; Dec. 7, 1903.

P. S.—There is no similarity between my electromagnets and those described in the number of February, 1901.

[As M. de Mare does not state what errors were committed in the comment to which he objects, we are unable to assist him in determining the cause of them. His statement as to the performance of two magnets is an arbitrary assertion, not an argument; moreover, if two electromagnets "differ in nothing but the method of winding," one of them cannot very well have a solid core while the other has a laminated core. We stated clearly, as we thought, that the lamination of the core was an advantage, the object of our criticism being the disposition of the winding only. We did not state that the de Mare magnet was similar to the magnet described in the February, 1901, issue; we merely said that the results obtained were similar in both cases. We will gladly publish any demonstration of the soundness of M. de Mare's views with which he may favor us, provided such demonstration be based on the recognized laws of electromagnetic phenomena.—EDITOR.]

NOTES.

The Annual Meeting of Electrical Contractors.—The annual meeting of the United Electrical Contractors' Association of New York State was held on January 19 at the Building Trades Club. The following are the officers-elect: President, Mr. Marshall L. Barnes, Troy, N. Y.; vice-president, Mr. James R. Strong, New York City; secretary, Mr. Frederick Fish, Rochester, N. Y., and treasurer, Mr. J. C. Stearns, Buffalo, N. Y. An enjoyable banquet was given by the Electrical Contractors' Association of New York City in the evening at Delmonico's. Mr. J. C. Hatzell made the welcoming address, in which he congratulated the delegates on the results of their day's labors and told them that they might justly consider themselves among the great captains of industry since they moved, or helped to move, the wheels of commerce. It required, he said, no great stretch of the imagination to predict that electricity would eventually be the sole motive power for these wheels.

Electrical Equipment of a Modern Newspaper Building.—Some details of the electrical equipment for the new home of the *New York Times*, at Broadway and Forty-second Street, New York City, have been given out. A remarkable feature of the equipment is that although 1000 kilowatt-hours of power will be required daily, this will not be supplied by an isolated plant but by the New York Edison Company. The following is a list of the uses and applications of electricity in the building:

One hundred and eleven motors—4 Hoe octuple presses; 1 press, job; 1 press, electric proof; 8 Kohler safety devices for controlling press movements; 2 autoplates, turning out eight stereo plates per minute; 38 linotypes; 3 pumps, house; 3 pumps, sewage; 1 pump, air compression for pneumatic tubes; 1 pump, air vacuum for cleaning carpets and offices; 1 pump, ink; 1 paper conveyor, for carrying printed papers from presses to delivery room; 7 elevators, passenger and lift; 4 Leonard system of control for elevators; 1 gallery lift; 8 trolley hoists for paper rolls; 8 fans for metal pots and for ventilating press room; 6 gymnasium; 1 machine shop lathe; 1 machine shop lathe; 1 stereo molding machine; 1 stereo tail cutter, round; 1 stereo shaver, round; 1 stereo router; 1 stereo shaver, flat; 1 stereo trimmer, flat; 1 stereo saw; 1 stereo jig and drill machine; 3 refrigeration.

Light—4000 incandescent, 15 arc, Cooper Hewitt lamps, search, signs, bulletin service, elevator flash, cigar lighters, carriage call.

Heat—Stereo matrix; restaurant, including plate warmers, coffee urns, tea kettles, egg boilers, griddles, self-dumping oyster cooker for stews, toasters; stereo pastepot; soldering irons; hair curler for ladies' toilet; heating pads; heating tailors' irons.

Dental—Mallet, gold annealer, sterilizer, dental engine, mouth lamp, porcelain baking furnace, reflector for working on dark days, X-ray apparatus, cautery.

The Electric Railway Test Commission of the St. Louis Exposition held its second meeting in New York on January 27. All of the commissioners, namely, Mr. J. G. White, chairman, and Messrs. H. H. Vreeland, James H. McGraw, George F. McCulloch and W. J. Wilgus, were present, and a great deal of work was accomplished in furthering the plans for an elaborate series of tests of electric railway equipment at the Exposition.

A great deal of interest has been manifested by electric railway engineers in the proposed tests, and the value of the engineering data which in all probability can be accumulated in this way is not to be overestimated. The work has been divided into four main divisions, and four committees of engineers who are specialists in the several divisions of electric railway work have been appointed to prepare a schedule of the tests to be made of the equipment offered in each class. These special committees are to arrange tests of City and Suburban Equipments; Interurban Equipments; Heavy Traction Equipments, and A New System of Electric Traction. The committees are expected to submit their reports to the Commission on or before February 22, and the next meeting of the Commission will take place in New York on February 29, at which time the reports will be considered.

Lighting at the St. Louis Fair.—The contract for lighting the World's Fair, which is the largest illuminating contract ever let, has been awarded. It provides for supplying the exposition with 300,000 incandescent lamps. An idea of the distribution of these lamps may be had from the fact that 12,000 are to be placed on the Palace of Education alone. The classical outline of that building eliminates brilliant color effects, but furnishes a splendid setting for night effects produced by electric lights. It has been decided to place on each of the monumental standards which dot the main avenue of the exposition on the border of the waterways 24 incandescent lamps. Each of the standards has four cast-iron pendants, on each of which there will be six lights. The "Pike" or Midway will be furnished with sufficient lights to render it brilliantly illuminated. Each of the standards along the central avenues will hold 24 lamps, so distributed that 12 will hang on each arm of the supporting post. The lamps contracted for will be used exclusively for exterior lighting. The interior of the exhibit buildings, which will be closed at sunset, will be lighted by arc lamps, the chief object of this lighting being for patrol purposes. The western half of the facade of the Educational Building has been equipped with lamps as a test section for the purpose of trying the effects of lights between the columns. These tests have proved satisfactory in every way.

Erection of a 5000-kw Turbo-Generator.—C. G. Y. King, mechanical engineer of the Chicago Edison Company, gave a very interesting lecture on January 8 before the Chicago Electrical Association on the erection of the 5000-kw. turbo-generators in the mammoth plant of the Commonwealth Electric Company of Chicago. Mr. King illustrated his lecture with a large number of lantern slides, showing the different stages of the work and the parts of the steam turbines, and also some photographs and plans of the station. He illustrated, among other things, the method adopted for adjusting the foot-step bearing at the lower end of the vertical shaft, so that the proper clearance could be maintained between the moving and stationery blades of the turbine. He also illustrated the electric valves by which the admission of steam to the turbine is regulated. In the original design of the foot-step bearing which takes the weight of the turbine it was intended to adjust this bearing by means of a nut under the turbine with the expectation that once adjusted it would remain permanently in proper adjustment; but, as Mr. King remarked, "it would not stay adjusted, not even for five seconds," and means are now provided whereby the adjustment can be regulated by a hand wheel on the operator's platform of the turbine. The engineer can therefore make this adjustment at any time. The balanced steam valves electrically operated which admit the steam to the turbine nozzles, were also illustrated. These valves are of the poppet type and are normally held closed by the steam pressure behind them. When steam is to be admitted through this valve, a small steam valve operated by a solenoid relieves the steam pressure which holds the poppet valve shut and unbalances the valve so that it opens; the area exposed to steam pressure tending to open the valve in this case being greater than the area exposed to the pressure tending to close the valve. A number of these valves are provided and the governing of the turbine is effected by opening and closing these, each valve being either full open or entirely closed. There is no throttling action. The revolving field magnets of these turbo-generators have six poles. The speed is 500 revolutions per minute, which of course gives a frequency of 25 cycles per second. The generators are 9000-volt 3-phase machines. In connection with these steam turbines, surface condensers are used. Each condenser has a wet and a dry air pump, driven by a Corliss engine and a centrifugal pump, to supply circulating water. The power station is located between two slips of the Chicago River; the condenser circulating pumps take water from one slip and discharge into another slip on the downstream side. Speaking of the design in the power station, Mr. King likened it to a comb, the turbine room or row of turbines corresponding to the back of the comb, and the batteries of boilers to the teeth of the comb ranged at right angles to the turbine room. Each turbine has a battery of boilers sufficient to supply it independently of the other batteries of boilers.

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Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

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The American Electrician has a larger paid circulation list than any other electrical journal in the world.

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Lost.

A package of our mail matter was lost in transit last month. If any of our correspondents who have written recently to either the editorial or business department have failed to receive a reply, we will, therefore, thank them if they will send duplicates of the unanswered letters.

◆

Superheated Steam.

In a paper read before the Rugby (England) Engineering Society, Mr. E. A. Reynolds brought out some interesting features concerning the use of superheated steam; an abstract of his remarks is printed in our Contemporaries department this month Possibly the most important of his conclusions was that most of the advantages of superheated steam are obtainable with a compound engine by applying the superheat after the steam has passed through the high-pressure cylinder, without entailing the disadvantages incident to very high initial temperatures. Of course, superheating receivers are by no means novelties, and we have long since learned that the chief benefit derivable from the use of superheated steam is the elimination of condensation. But the immense amount of work done by Schwoerer, Schmidt and others in the perfection of individual superheaters and engines built with a view to using superheated steam from the beginning of the cycle would seem to have been misdirected if it is unqualifiedly true that all the desired improvement could be obtained by superheating after the first stage.

In most discussions of superheated steam economy, the water consumption of the engine is made the criterion of its performance; it is scarcely necessary even to suggest that, in the absence of figures relating to the coal consumption per pound of steam delivered to the engine and the calorific value of the coal, the weight of steam per unit of delivered work means little or nothing. In some cases (not published very widely) it has been found that the saving in actual coal and water consumption per unit of delivered work did not offset the fixed charges on the superheating equipment and the increased wear and tear on the engine. In many other cases, however ("many" being relative, since there have not been a great number of total cases as compared with the number of engines operated with saturated steam), the actual saving has been worth while. Of course, the possible saving by superheating depends on the type of engine and also on its size; the margin is considerably greater for a simple than for a compound engine, and slightly greater for the latter than for a triple-expansion engine.

One of the interesting, though academic, features of the superheated steam problem is that the advantages theoretically obtainable by adding extra heat were recognized to a certain extent about 75 years ago. The newness of the matter is restricted to the practical investigations and experiments made by Schmidt and others in Europe. A mine owner in Cornwall, England, in 1828 built a brick jacket around his engine cylinder and maintained a fire within this jacket, by means of which arrangement he increased the amount of delivered work per unit of coal by about 50 per cent. (It is fair to assume that the initial economy was pretty low.) The celebrated John Ericsson made some fugitive experiments with superheated steam about 1835, and in 1852 a Frenchman named Rafford took out patents for apparatus for superheating steam. The work in this direction was discouraged by the difficulties of lubrication, however, the present mineral and heavy cylinder oils being then unknown, and when the practicability of multiple-expansion engines became established attention was diverted from the use of superheat by the conspicuous gains obtained with such engines. Having practically exhausted the possibilities of multiple-expansion, the old problem of superheating was naturally revived by engine designers.

◆

Electrolytic Rectifiers.

In the report of the convention of the Northwestern Electrical Association which appears in another part of this number will be found an abstract of a paper read by Prof. C. F. Burgess in which he describes generally a new electrolytic rectifier that has been built at the University of Wisconsin and manifests an apparently optimistic attitude toward it. It does not appear, however, that the future of this class of apparatus can be highly favorable, even though unusually good results may have been obtained in this case. While it may be preferable to a rotary converter in very small sizes, an electrolytic rectifier cannot compare with a converter in medium and large sizes, and the advantages of a combination of transformer and electrolytic rectifier are somewhat doubtful.

It is at least of theoretical interest, if not of practical importance, that electrolytic rectifiers must cause dissymmetry of the alternating-current wave in the other parts of the circuit which supplies them. It is true that arc lamps and unbalancing of the load on polyphase circuits will change the wave form, but always symmetrically so that there are no even harmonics in any part of the circuit, whereas the rectifier changes the wave form dissymmetrically. It is of decidedly practical importance, however, to note that this type of rectifier may require a much longer time to deliver a given battery charge than would be required with a rotary converter or a motor-generator. It is the result of observation that an open-coil, direct-current dynamo takes longer to charge a given battery than a closed-coil machine, the ammeter readings being the same in both cases. This appears to be due to an effect caused by the rapid current variations. Pof. Samuel Sheldon discovered that applying alternating current to a storage battery does not leave the battery unchanged by the superposition of equal and opposite electrolytic effects, as one might naturally expect it would, but causes a progressive sulphating of the plates. It would appear from this that, even where the charge impulses are much larger than the discharge impulses, a material portion of each charge would be used up in decomposing the sulphate produced by the reversals. At all events, this explanation fits the facts perfectly. For this reason, unless the reverse-current impulses through an electrolytic rectifier should be of negligible magnitude, the time required for charging a given battery will be considerably longer than with a rotary converter.

In charging storage batteries with a pulsating or undulatory unidirectional current, the arithmetic mean value of the current is what should be indicated by the ammeter, for this is the measure of the electrolysis going on in the batteries. This is precisely what is indicated by a direct-current ammeter, while the indications of an alternating-current ammeter, namely, the geometric mean values, are proper for power purposes. This is more particularly the case if the reverse current required to close the hypothetical valve be not a negligible quantity. That is to say, if the reverse current required to form the non-conducting film or films which arrest the further flow of the very current which forms them, be of a sensible magnitude, it will be added to the useful current by an alternating-current ammeter, but will be subtracted, as it should be, by a direct-current instrument.

The New York Central Equipment.

As previously announced in our columns, the New York Central & Hudson River Railroad Company is perfecting its plans for hauling all trains into and out of New York City by means of electricity. The corps of experts engaged to work out the details of the plan have decided to use direct-current locomotives for hauling the trains, and to make the change from steam to electric traction at Croton on the Hudson River division, and at White Plains on the Harlem division. Two power stations will be established, one on the upper east side of the city, near the junction of the Harlem and East Rivers, and the other between Yonkers and Tarrytown, about 45 miles from the Grand Central Station. The generators will be three-phase alternators, driven by steam turbines, as also announced previously. There will, of course, be rotary converter sub-stations at suitable intervals for feeding the distribution mains. The locomotives will be of 2200 horse-power each and equipped with gearless motors; the maximum speed ability is to be 75 miles an hour for a single locomotive hauling a 500-ton train. The details of the system of working conductors have not yet been made public, but it is understood that the third rail will be used everywhere except in the terminal yards, where the multiplicity of switches makes the use of a hooded rail almost impossible and an unprotected rail would be murderous. Here some form of overhead working conductor will probably be employed.

This is one of the most striking examples of the wisdom of putting important work in the hands of experienced and conservative specialists that has been presented for many years. The only feature of the whole plan that might be considered in the least degree of problematical expediency is the use of a comparatively untried type of steam turbine, and in view of the character of the contract made with the builders and the reputation of the latter the risk involved by the decision to use this turbine is undoubtedly negligible. The decision to use direct-current motors is indicative of the conservatism of the engineering committee. While alternating-current traction is most promising and is certain to come ultimately, its fitness for work of the magnitude involved here has not been demonstrated, and this was certainly not an appropriate occasion to indulge in an initial demonstration and weed out the objectionable features which inevitably would have developed. The system *must* work reliably from the very first moment that it displaces the steam system of haulage.

Meters.

The vagaries of the gas meter have long been a favorite theme for vigorous discussion by patrons of gas companies, and it is very probable that to past experience with these unsatisfactory contrivances more than to any other one cause was due the stubborn opposition to the introduction of electric meters that was manifested by electric light users when meters first reached the really commercial state. Leaving aside the marvellous tales told by persons who may have been influenced by bitter prejudice or ulterior motives, it is undeniably true that gas meter records are in most cases inconsistent with the actual service rendered the consumer. We have personal knowledge of cases where the meter showed a very considerable consumption of gas during a period when the consumer's premises were locked up, all the keys in the householder's possession, and all of the family continuously sojourning miles away; the piping and jets had been thoroughly tested for leaks before closing the house and were again tested upon the return of the occupants. There are, again, indisputable cases of decreased service being accompanied by increased gas bills.

Most of the discrepancies between records and service that have been charged against the gas meter are impossible in the case of the electric meter, and the others are highly improbable. A meter may run fast (or slow) and it may creep when there is no load; these constitute practically the whole category of its vices. It is utterly impracticable to increase the pressure on the mains enough to affect the meter record appreciably, and the quality of the current cannot be impaired without lowering the meter bill, *i. e.*, some worthless meter-operating medium cannot be sent through the wires instead of electricity. Moreover, while the mysteries of the meter dials are, as a rule, beyond the average consumer, he can readily see if his meter creeps without load, and prove it beyond dispute. And there is no known method by which a reduction in the number of lamp-hours used can produce an increase in the record of the meter. Everything considered, therefore, the average user of artificial illuminants is much safer at the mercy of an electric meter than with the time-dishonored gas meter.

DESIGN FOR A TWO CYCLE GASOLINE MOTOR.

BY J. C. BROCKSMITH, M. E.

The accompanying working drawings show a two-cylinder two-stroke-cycle air-cooled type of gasoline motor that is particularly adapted to light automobile work. The advantage of a two-cycle motor lies in its extreme simplicity, it being entirely free from valves, cams, gears, etc., and their consequent noise and liability to derangement. The machine is still further simplified in the present design by the use of air-cooling flanges, thus avoiding the use of a water circulating system with its pumps, piping and radiators, all of which are likely to cause trouble.

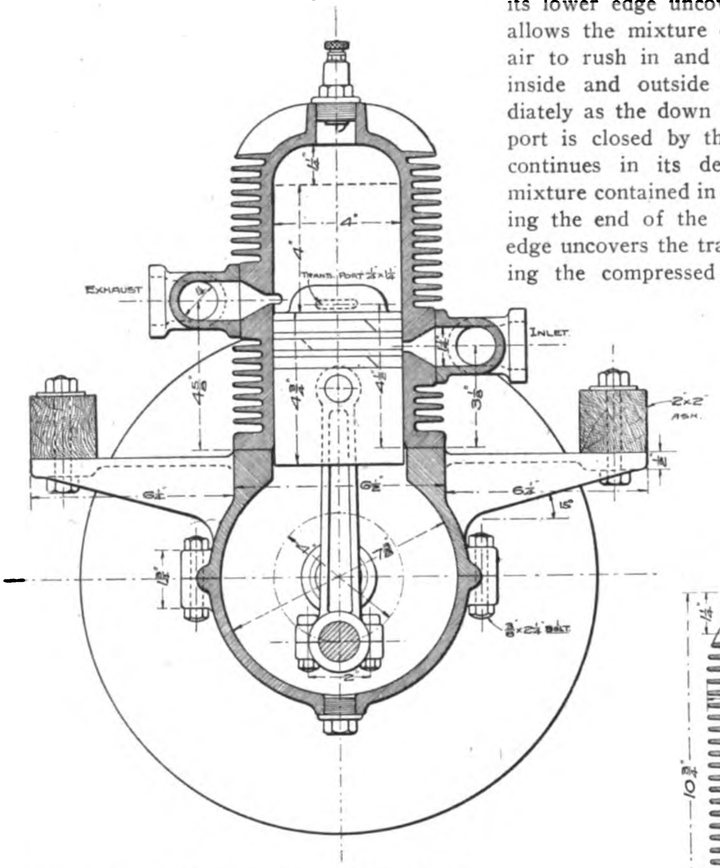


FIG. I.—FRONT SECTION OF GASOLINE MOTOR.

A further advantage of the two-cycle motor is that it ordinarily receives an impulse at each revolution of the crank shaft and in the case of a two-cylinder motor at every half revolution of the crank shaft, thus making it comparable to a four-cylinder four-cycle engine as far as regularity of turning effort is concerned.

The two-cycle type of gas engine has some disadvantages, first of which is its inability to operate at very high speeds and its consequent restricted output per unit of weight. From the nature of its cycle of operations the incoming charge and outgoing gases in the cylinder cannot avoid intermixture to some extent, this becoming greater with increased speeds, so that the combustion of the charge is not as complete as in the four-cycle engine and consequently it cannot deliver as great an amount of energy per stroke. It has been sought in the present design to minimize this intermixture of the charge with the exhaust by a novel arrangement of the transfer passages and deflecting surfaces on the piston head. The operation of the engine, considering only one cylinder at a time, is as follows:

On the upward stroke of the piston a partial vacuum is formed in the crank case which is air-tight and has no communication with the outside air until the piston reaches the upper end of its stroke, when its lower edge uncovers the inlet port and allows the mixture of gasoline vapor and air to rush in and equalize the pressures inside and outside the chamber. Immediately as the down stroke begins the inlet port is closed by the piston, which, as it continues in its descent, compresses the mixture contained in the crank case. Reaching the end of the down stroke its upper edge uncovers the transfer port, thus allowing the compressed mixture to pass into the cylinder.

On the next up stroke the transfer ports are first closed by the upper edge of the piston and the mixture contained in the cylinder is then still further compressed by the piston until it occupies the clearance space at the top of the cylinder, which is about 25 per cent of the stroke volume. At the end of the up stroke a spark passes at the plug and the compressed mixture is ignited and drives the piston downward When it reaches nearly the end of its down stroke the exhaust port is uncovered by its upper edge, slightly in advance of the uncovering of the transfer passages, and the expanded gases pass out. Immediately following this the transfer ports are opened and fresh mixture, which has in the meantime been compressed in the crank case, rushes in. The incoming charge enters in two streams from diametrically opposite points in the cylinder wall, whence they are deflected upward by curved vanes on the piston head; this action has the effect of clearing the cylinder of the exhaust gases by forcing them down and out and leaves the cylinder filled with nearly pure mixture ready to be compressed and ignited on the next up stroke of the piston. This cycle is repeated over and over, and the same thing occuring in the other cylinder, with the cranks at 180°, gives two impulses in each revolution.

It is obvious, of course, that the two compartments of the double crank case must be entirely independent of one another and also that they must be of such volume that the mixture will be compressed to some point slightly greater than the exhaust pressure. This, however, is susceptible to some adjustment by the insertion in the crank case of blocks of wood or metal in the space not actually necessary for the rotation of the cranks.

Fig. 1 is a front vertical section through the completed motor, which shows the size and location of the various ports and passages, the piston acting as its own valve in the manner above described in addition to its usual function of driving member. The cylinder has a 4-inch bore and 4-inch stroke, the bore being unusually large for an air-cooled motor. It need not be feared that this will result in overheating, as the engine is intended to operate at a moderate speed and output and in addition to this the fact that the activity in the cylinders is less will contribute to cool running. The maximum speed should be about 750 r.p.m. when the power will be about 6 horse-power.

The crank case is split along a horizontal

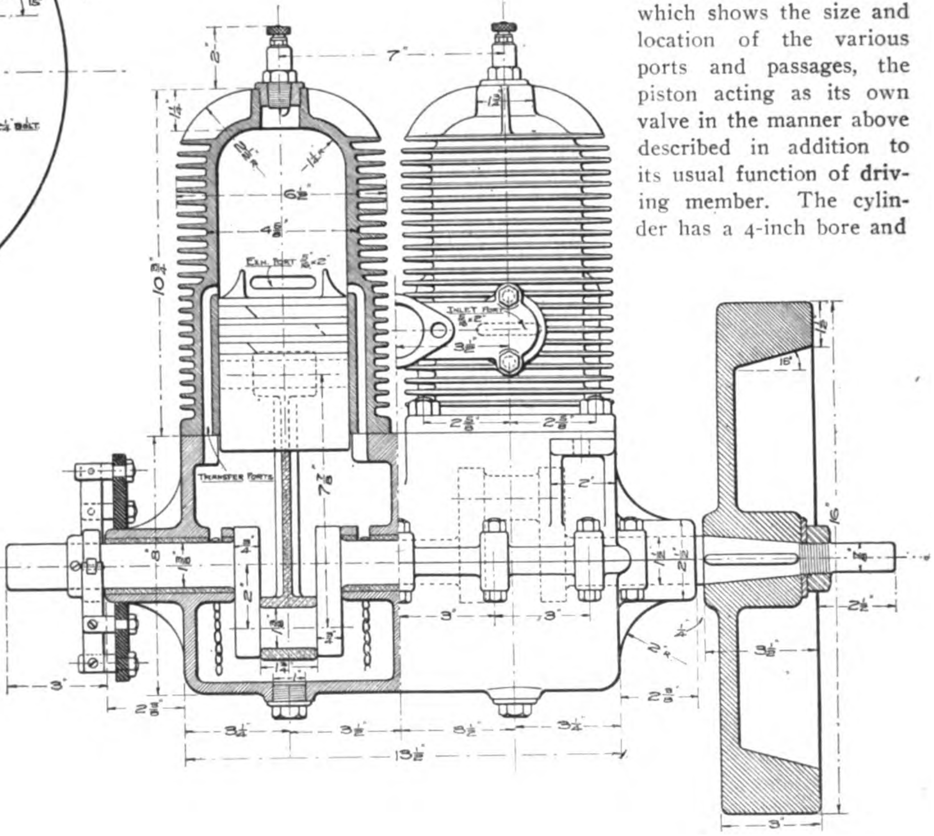


FIG. 2.—SIDE SEMI-SECTION OF GASOLINE MOTOR.

plane and is of comparatively small diameter, the flywheel being placed outside. Arms cast on the top half of the case enable it to be bolted to the framework of the car so as to afford proper clearance for rotation of the flywheel. The piston is long and has three rings for packing. These are made of greater width than the ports in the cylinder walls so that there is no liability of their becoming caught.

Both the inlet and the exhaust sides of the cylinder are provided with branch pipes which allow the piping to the engine to be reduced to the simplest possible arrangement, *i.e.,* one supply pipe and one exhaust pipe.

The spark plug is tapped into the center of the cylinder at the top, where it is in a good position to ignite the charge and is also accessible for inspection and cleaning, which is sometimes necessary.

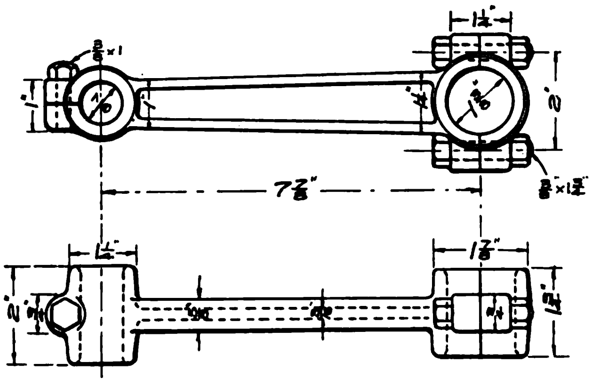
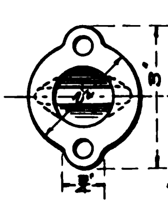


FIG. 6.—DETAIL OF CONNECTING ROD.



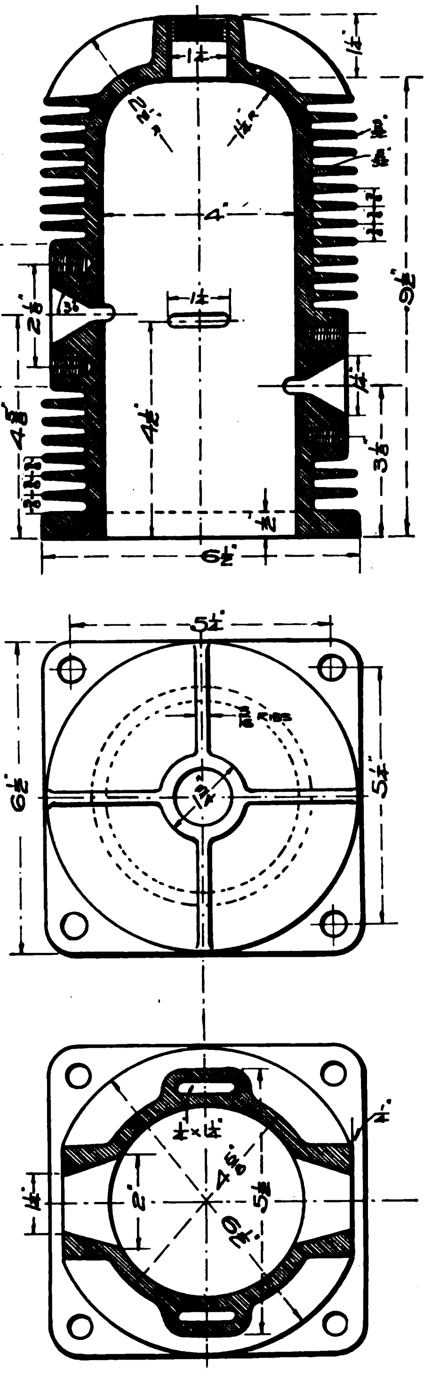


FIG. 3.—DETAILS OF CYLINDER.

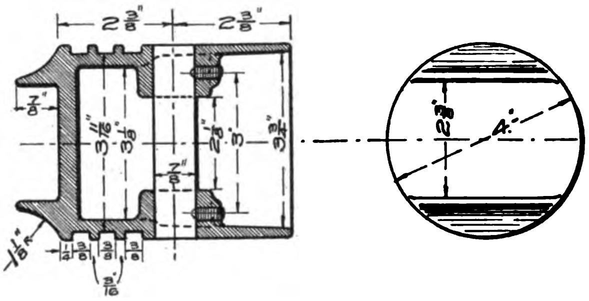


FIG. 5.—DETAIL OF PISTON.

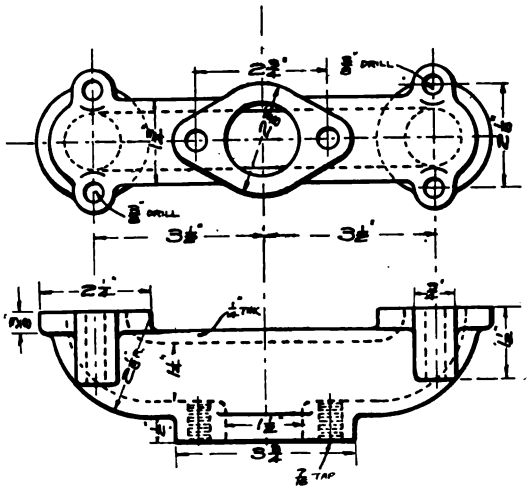


FIG. 4.—DETAIL OF BRANCH PIPE.

Fig. 2 is a semi-sectional side view of the complete motor. This shows the transfer passages which connect the cylinder with the crank case; it also brings out the shape of the deflecting vanes on the piston head, and the branch pipes which connect the two cylinders. The contact maker is shown in this view located on the bearing boss, and is adapted to be rotated about the cam, thus varying the time of ignition in the customary manner, to obtain various speeds. The shaft is extended somewhat on this end so that a starting crank handle may be fitted on.

The other end of the crank shaft carries the flywheel, which is of the cone clutch variety, and is extended somewhat beyond the hub of the wheel for the purpose of centering the male portion of the clutch.

There are three main crank shaft bearings, all of which are bushed with phosphor bronze bushings and may be lubricated by means of chain oilers from oil contained in the crank case or by means of felt wipers, as may be desired. The other parts are oiled by the splash, including the cylinders, which may be provided with splash plates if found necessary. Oil plugs are provided on the crank case for draining off the used oil and renewing the supply.

Fig. 3 gives the details of the cylinder; a vertical and a horizontal section of the cylinder are shown and also a top view. The cylinders should be cast in good close-grained grey iron. Two are required, just alike.

The cylinder wall is 5/16 inch thick and is provided with 23 flanges 15/16 inch high for the purpose of increasing the radiating surface and thus maintaining the temperature of the cylinder wall at such a point that lubrication can be effectually accomplished. The flanges are made tapering in thickness from 5/32 inch at the base to 3/32 inch at the apex. This is mainly to facilitate moulding, which is difficult at the best.

The vertical section shows the size and proper location of all the ports in the cylinder wall, the inlet and exhaust ports being both 5/16 x 2 inches and the two transfer ports ¼ x 1¼ inches each. The horizontal section of the cylinder is taken through the center lines of both inlet and exhaust ports, and helps to make clear the location of the transfer passages cored out in the cylinder wall.

The end view of the cylinder shows four 3/16-inch ribs across the top of the cylinder head and also the boss which is bored to 1¼ inches so as to take a 1¼-inch boring bar for use in boring out the cylinder. It is afterward threaded and bushed to receive the spark plug. This view also shows the flange at the bottom of the cylinder and the layout of holes by means of which the cylinders are bolted to the crank case. The holes are drilled ½ inch for studs or cap screws. This flange is, of course, faced at the same operation as boring the cylinder.

Fig. 4 is a detail of the branch pipe which connects the two cylinders on both the inlet and exhaust sides of the engine. Two such pipes are required; they may be cast of iron or aluminum alloy as desired. It is probable that the aluminum alloy can be used for both sides, although there is some question of overheating the metal on the exhause side and thereby causing it to become brittle and crack. The pipe is cored with a 1¼-inch round hole, the walls are ¼ inch thick, and where connection is made to the common pipe the size opening is 1½ inches. The pipe is bolted to pads on the cylinder by means of ⅜-inch studs or cap screws. These joints need not be very accurately fitted, as there is no great pressure at these points, and they can further be packed with asbestos washers if necessary.

Fig. 5 is a detail of the piston; this is of cast iron, and two are required. It has three grooves turned for ⅛-inch rings. The rings should be turned up about 1/64 inch or more larger than the finished bore of the cylinder and ⅛ inch thick. They are then cut through with a diagonal slot taking out about 3/64 inch, and should be fitted to the bore of the cylinders so that the ends stand a little apart so that when they warm up during running and expand they will not seize. The body of the piston should be turned two or three one-thousandths small for the bore of the cylinder, as the pistons in an air-cooled motor are more liable to stick than in a water-cooled machine, and should therefore be a comparatively free fit when cold. The grooves should be turned a nice fit for the rings, which can then be snapped into place and pinned to the piston with the joints at 120° intervals and occupying the positions indicated in Figs. 1 and 2 so that the joints are not required to traverse that portion of the cylinder wall which is broken by the ports.

The wrist pin is ⅞-inch cold rolled steel and is held in position by means of two ¼-inch set screws in the inwardly projecting bosses on the piston. An improved lubrication of the wrist pin bearing can be secured by drilling a hole through the pin from end to end and connecting this with a hole at right angles that enters the bearing surface. A small groove could also be turned in the piston communicating with the hole in the wrist pin; the bearing would then receive a good supply of oil gathered from the cylinder wall.

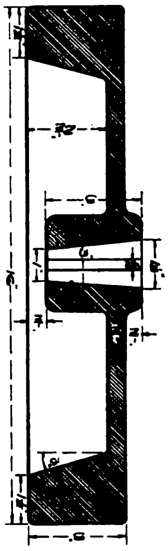


FIG. 8.—DETAIL OF FLY-WHEEL.

Fig. 6 is a detail of the connecting rod, which is intended to be a phosphor bronze casting; two are required. Provision is made at both ends of the rod for taking up wear. The box at the crank end of the rod is made 1⅜-inch bore for one cylinder and 1½-inch bore for the other, to correspond to the crank shaft sizes. The body of the rod is of "I" section with a 3/16-inch web.

Fig. 7 shows the crank shaft. This is preferably made from a solid open-hearth steel forging, the cranks themselves being cut out of the solid metal. It would save the builder considerable time in machining, however, if he can secure a good sound steel casting which could be made very nearly to finished size and thus leave a minimum amount of metal to be removed in finishing.

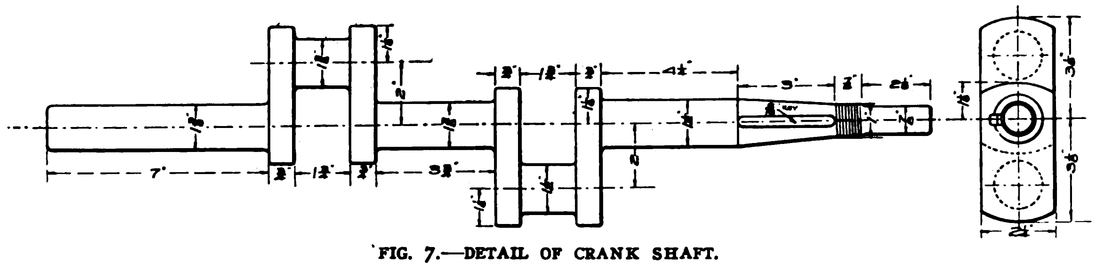


FIG. 7.—DETAIL OF CRANK SHAFT.

In machining the cranks it will be necessary to make a couple of cast-iron dogs to slip over the ends of the shaft, fastened by set screws, upon which to locate the centers for turning up the crank pins. The crank shaft itself should be left about 1/16 inch oversize until the crank pins have been finished, when the gaps may be blocked and a finishing cut taken over the shaft. All angles on the crank shaft should be filleted to ⅛ inch radius or more.

Fig. 8 is a detail of the flywheel. This is of cast iron and is to be turned all over, the inner surface of the rim being finished to a 15° angle for use as a cone clutch. The hub is bored taper and keyed. This wheel will weigh about 85 pounds finished and should be amply heavy to insure smooth and regular motion.

Figs. 9 and 10 show respectively the details of the upper and lower halves of the crank cases. These are intended to be cast of aluminum alloy containing about 25 per cent of zinc. They can also be made in cast-iron, where it is desired to reduce the cost, and could then be considerably thinner (about 3/16 to ¼ inch thick) and still have ample strength. In finishing the top half, the pads on which the cylinder is bolted are first planed and then the surfaces of both halves where they bolt together should be finished. The lugs may then be drilled and the two halves bolted together, after which the seats for the main bearing may be bored. Particular care should be exercised to make a tight job of the joint in the crank case. A thin asbestos gasket may be inserted if it is found necessary, but it is much preferable to obtain the desired result without the use of packing, relying only on the careful surfacing of the metal and the numerous bolts for drawing the parts together.

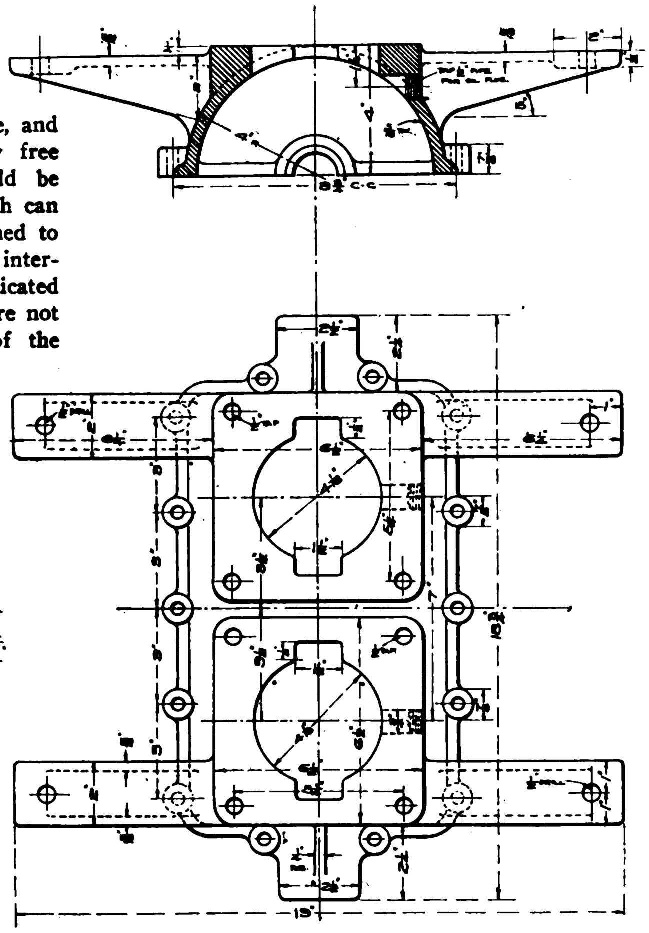


FIG. 9.—DETAIL OF UPPER HALF OF CRANK CASE.

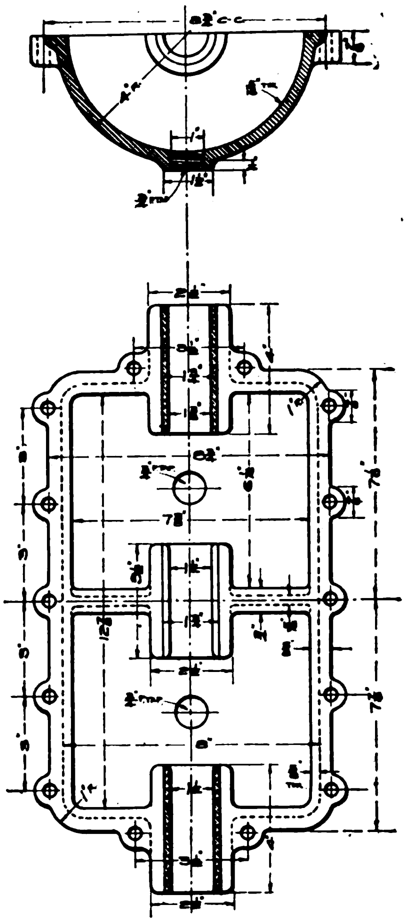


FIG. 10.—DETAIL OF LOWER HALF OF CRANK CASE.

The bearing bushings are to be of phosphor bronze 3/16 inch thick; the two outside bearings may have one-piece bushings, but the center bushing must be split, of course, one-half being pinned into each of the crank cases.

The ½-inch tapped holes in the top of the crank case can best be laid off from the cylinders when the parts are all in their proper positions. Two holes are tapped into the side of the top case for oil filling plugs. In making a pattern for the crank case the work will be much simplified if a complete pattern is made for the bottom half only. To this can be added, as change pieces, the pads and arms which differentiate it from the top half of the case. In this way castings for both top and bottom halves can be obtained with a minimum amount of pattern making.

Fig. 11 is a detail of the contact maker for use with jump spark ignition. A spark is required in each cylinder once at each revolution of the crank shaft, of course. The cranks, however, are at 180° and hence two contacts 180° apart are employed, one connected with the primary belonging to the first cylinder and the other to that belonging to the other cylinder. This is the method employed where a separate spark coil is used for each cylinder. The other way involves the use of a single coil and commutation of the high-tension current, which is not considered to be very practical. Fig. 11 shows the construction of the device, which consists of a cam on the crank shaft of the engine operating two small rollers attached to spring-steel blades which have a platinum contact riveted to about the middle of their length. The rollers are adjusted to just clear the circular portion of the cam, and once in each revolution the cam presses each of the contacts together and makes connection with the battery. The stationary contacts consist of a machine screw having a bit of platinum riveted or brazed into it.

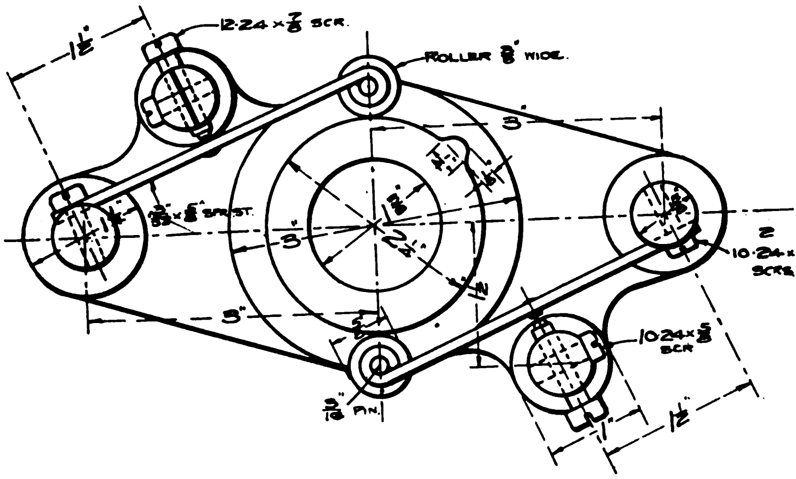


FIG. 11.—DETAIL OF CONTACT MAKER.

The plate upon which the contacts are mounted is bored for and centered upon the main bearing boss and may be rotated about the boss to change the point of ignition. This plate may be made of aluminum or brass and only the stationary contacts need to be insulated from it. That is to say, the spring blades are grounded on the frame of the engine, which is a necessary part of the scheme of connections.

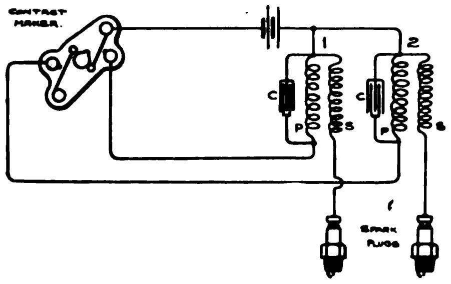


FIG. 12.—DIAGRAM OF IGNITER CONNECTIONS.

Fig. 12 is a diagram showing the connections between the contact maker, spark coils, battery and plugs. There will be five wires in all running to the engine, three to the contact maker and two to the spark plugs. The latter two should be very heavily insulated, as the sparking current is of very high voltage and most ordinary insulations allow a serious leakage of current. For the spark coils and plugs the builder will do well to purchase standard articles, as these details have been worked out by manufacturers only after much costly experimenting, so that the amateur will save both time and money in securing finished product.

In order to operate the motor on gasoline some form of float-feed carburettor is necessary which will give a constant and reliable mixture at all speeds. Here again the builder will do well to purchase an article of reputable make. A really good carburettor is quite a difficult proposition in itself.

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VALVE GEARS.

Effect of Connecting-rod Angularity.

BY C. C. MAJOR.

The function of the valve of a single-valve steam engine is to admit steam into one end of the cylinder behind the piston, to cut off the supply of steam at any desired point in the stroke so that the expansive force in the steam may be utilized; also to allow the exhaust steam to escape from the cylinder after it has given up its energy to the piston and to close the exhaust port in order that a certain volume of steam may be retained in the cylinder to form a cushion for the piston and other moving parts of the engine. Before taking up the description of the various styles of valve gears and valve diagrams, it is advisable to consider the effect of the angularity of the connecting-rod on the steam distribution. The harmful effect of this angularity increases as the length of the connecting-rod decreases and *vice versa.* Consequently, it is desirable to have the connecting-rod as long as is consistent with good design for other parts of the engine. Usual practice makes the connecting-rod from four to six times the length of the crank.

For every crank position there is a corresponding piston position and the distance the piston travels from either end of its stroke for any given angle through which the crank has turned may be computed mathematically or found approximately by a graphical method.

In Fig. 1, let *M-C-N-H-M* be the crank circle; *O-M,* the length of the crank, and *R,* the length of the connecting-rod which is taken four times the length of the crank. When the crank is at its dead-center *M,* the cross-head will be at *A,* the end of its travel farthest from the cylinder, and when the crank is at its opposite dead-center, *N,* the cross-head will be at *B,* its nearest point to the cylinder. Since the piston and cross-head travel together, the distance *A-B* may be considered the path of the piston instead of the cross-head, and the distance the piston travels will be reckoned from *A* and *B.* When the crank-pin has traveled from *N* to *C,* the crank has turned through an angle of 60° and the piston has moved from *B* to *L* on the forward stroke; and when the crank-pin is at *H,* its corresponding position on the return stroke, the piston will be at *K* and will have passed over the distance *A-K.* From the centers *K* and *L,* with the connecting-rod length *R* as a radius, draw the arcs *H-E* and *C-F.* Then $N\text{-}F = B\text{-}L$ and $M\text{-}E = A\text{-}K$.

To find *N-F* and *M-E* the following simple formulas may be employed:

$N\text{-}F = O\text{-}N - O\text{-}G + F\text{-}G$ and

$M\text{-}E = O\text{-}M - O\text{-}D - D\text{-}E;$

$O\text{-}D$ and $O\text{-}G = r \cos a,$

and since $D\text{-}E = F\text{-}G = x,$ then

$$N\text{-}F = r\ (1 - \cos a) + x \ldots\ldots\ldots\ldots(1)$$

$$ME = r\ (1 - \cos a) - x \ldots\ldots\ldots\ldots(2)$$

The length of the crank r for any given case is known, and $r \cos a$ can be readily obtained from tables for any rotation of the crank, and it is necessary to find the value of x before we can solve for *NF* and *ME.*

From *H* draw the perpendicular *H-D* out to the center line *M-N* and about the center *K,* to the radius *R,* draw the arc, *P-H,* cutting the crank circle at *P* and *H.* Then

$x : H\text{-}D :: H\text{-}D : 2R - x,$

and since $H\text{-}D = r \sin a,$ then

$x : r \sin a :: r \sin a : 2R - x;$

$x\ (2R - x) = r^2 \sin^2 a,$

hence, $x = R - \sqrt{R^2 - r^2 \sin^2 a}.$

Substituting this value of x in equations 1, and 2, we have for the travel of the piston

$$N\text{-}F = r\ (1 - \cos a) + R - \sqrt{R^2 - r^2 \sin^2 a} \ldots\ldots\ldots\ldots(3)$$

$$M\text{-}E = r(1 - \cos a) - R + \sqrt{R^2 - r^2 \sin^2 a} \ldots\ldots\ldots\ldots(4)$$

Applying these formulas to a given case where $r = 1$ foot, $R = 4$ feet, and the angle $a = 60°$, by substituting these values in equations (3) and (4):

$N\text{-}F = 7.0$ inches.

$M\text{-}E = 4.99$ or practically 5 inches.

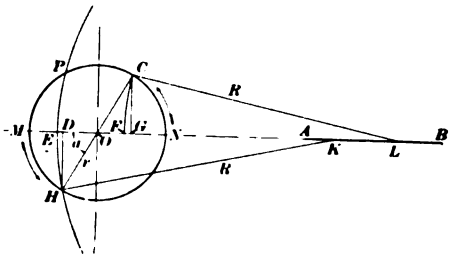

FIG. 1.

Formulas (3) and (4) are simple, yet they involve some knowledge of algebra and trigonometry and require a table of the functions of angles. Approximately the same results may be obtained by a graphical method as shown in Fig. 2. As in Fig. 1, *M-C-N-H-M* is the crank circle, *O-N*, the length of the crank, and *R*, the length of the connecting-rod, which is equal to four crank lengths; *A-B* is the travel of the cross-head and therefore of the piston. When the crank is passing the dead-center *N*, the piston will be at the head end of the cylinder as represented by *B*. For an angular rotation of the crank through 60°, the piston will travel to *L*, or 30 per cent. of its stroke. Then when the crank has turned through the equal angle *a*, from *M* to *H*, the piston will have traveled from *A* to *K*, or 20 per cent. of its stroke. With a 2-foot stroke as assumed in Fig. 1, these distances are 7.2 inches and 4.8 inches respectively. No attempt was made to make these figures tally with those obtained by computation, and they are only approximate. The larger the diagram, the more accurate will be the results obtained.

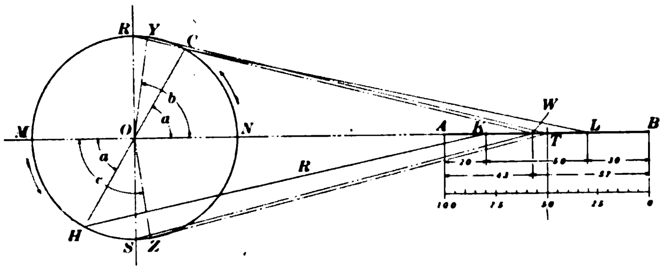

FIG. 2.

As the piston moves forward from *B* and reaches the position *T*, midway of its travel, the crank will pass through the angle *b* for the forward stroke and through the angle *c* on the return stroke. When the crank has turned through 90° from *N* to *R*, the piston has reached *W*, 57 per cent. of its stroke, and will therefore travel 43 per cent, the remaining portion of its travel, while the crank is turning through the second 90° from *R* to *M*.

The connecting-rod makes an angle with the horizontal at all times except when the crank is at the dead-centers, and it is evident from the above diagram that this angularity causes the piston to travel a greater distance from the head end than from the crank end of the cylinder for equal angles made by the crank after passing the dead-centers.

Unless counteracted by the design or setting of the valve, cut-off will occur later in the head end. Consequently steam pressure is exerted on the head end of the piston for a greater portion of the stroke than on the crank end, and therefore the rotative effect will be unequal, causing the angular velocity of the shaft and belt wheel to vary during each revolution. In most cases this variation would prove more objectionable than the effect of unequal steam distribution on the economy of operation of the engine. The method of counteracting the effect of the angularity of the connecting-rod will be discussed in a subsequent article.

BOILER ROOM PRACTICE.

BY W. T. EDWARDS.

It has been said that the first things a good engineer or fireman sees upon entering a boiler room are the gauge glass and the steam gauge. Certainly the first duty of a fireman upon taking charge of a boiler room is to ascertain whether or not the water is at the height in the boiler that is indicated by the gauge glass. This can be done by means of the gauge cocks, which should be kept clear and constantly used.

It is, of course, well known to experienced firemen and engineers that the water glass is prone to become clogged by scale and should therefore be blown out at intervals. It may not be quite so well known, however, that in blowing out the glass, the bottom connection should always be blown out first, with the upper valve opened and the two connections be allowed to blow clear together.

The safety valve should be tested at intervals to make sure it will lift from its seat easily. In order to avoid the labor of clambering over the top of the boiler or boilers, it is an excellent plan to run a stout cord (sash cord is a good kind) from the end of the safety valve lever, through pulleys to a point within easy reach from the firing floor. By means of this cord the valve may be tested without inconvenience once or twice a day, which is none too often.

Firing is not merely a trade; it involves an artfulness that is entirely incongruous with a fireman's surroundings and the amount of manual labor required. The handy man who may be able to "turn his hand" to anything with fair success will fail utterly when he tries to keep up steam on hard-worked boilers. Almost every fireman has his own pet method of firing, but the conditions under which the boilers are worked have a great deal to do with the thickness of the bed of fuel. The practice which seems to give the best results under average conditions is to keep the bed of coal perfectly flat and about 4 to 6 inches deep, firing lightly and spreading the coal evenly over the fire, and if the furnace has two doors, firing alternate sides. By using the scoop only part full of coal it will be found easier to place the coal just where it is wanted and with less danger of spilling it on the floor.

The practice of forcing a fire in order to get up steam in a short time can not be too strongly condemned. It subjects the boiler to strains for which it was never designed and that iron and steel will not stand. These strains shorten its life and induce leaks in seams and around flues. Sometimes, as a means of still further extracting a few stray heat units from the gases, they are returned to the rear of the boiler, where the flue is situated, over the boiler between it and the arch covering. This may be a means of a small saving but it should not be permitted, as it causes gases to come into contact with a part of the boiler shell that has not a direct water backing. This practice is prohibited by boiler insurance companies for the reason stated.

The fact that boilers expand when heated is of course well known; consequently every one who has a boiler to set provides means for the boiler to expand easily by placing rollers between the rear lugs and the bearing plates under them. This is very good, but in nine cases out of ten the boiler will be bricked in so tight that it can not possibly move without distorting the setting; such practice seems to be the height of absurdity. A good plan is to have a Z-bar riveted to the side of the boiler about level with, and parallel to, the top row of tubes, and the side walls carried up and racked over until the inside face of the wall is quite up to the Z-bar. The courses of brick are so spaced that a joint comes fair with the top of the Z-bar; then two or three courses are laid so as to come within about two inches of the boiler shell. The boiler should be set so that it hangs free and clear, and it is to be preferred that it be supported independent of the brick setting, but if that can not be done conveniently the rear lugs which bear on the rollers should have enough space to permit them to move without coming in contact with any brick work.

The back arch has been a source of trouble when turned against the rear head; this can be overcome by riveting to the rear head an angle one leg of which will extend over one side of a cast-iron V-shaped skew back that extends from one side wall to the other and forms a header for the back arch to head against. The Z-bars on the sides and the angle on the rear head form an almost gas tight joint and yet allow freedom of movement for the boiler. It should be said that the Z-bars and the angle should preferably be of cast iron as the gases have a very bad effect on wrought iron and soft steel.

The boiler may be covered with a layer of sand about two or three inches thick, and a sectional covering substituted for the usual brick arch. This covering can be made after the method of making slab floor of concrete and expanded metal. The expanded metal is cut into sections long enough to reach from the side walls to the center of the boiler on top, the sections of course conforming to the shape of the boiler, and they should be fairly narrow as the completed sections will be pretty heavy. The expanded metal should then be laid over the entire boiler, fitting around the dome and manhole, the top connection to the water column, and any other pipes that may be there. Then these sections of expanded metal are covered as a whole with a plaster made of magnesia, asbestos and clay, to a thickness of about three inches, fitting up to within about one inch around the dome and the same distance clear of the manhole. The plaster should be well worked into the openings of the expanded metal, as it is necessary to incorporate the metal with the plaster in order that the sections be of the required strength to hold together. While the plaster is still soft it can be separated along the lines of separation of the metal and then allowed to harden, these joints afterward being filled with the same plaster. The space around the dome can be filled with sand up to the top of the covering.

The advantages claimed for this way of covering in a boiler are, that it is easy to remove and replace in the event of the boiler being inspected, the sections being in such condition as to be ready to replace after inspection is completed, and that it does not require the services of a bricklayer to remove or replace. The ease with which it can be removed and replaced makes it more likely that the inspection of the boiler will be more frequently done and more thoroughly attended to. The function of the sand is to fill in all interstices about the boiler setting where it comes against the boiler and is of a sufficiently yielding nature to permit the boiler to move under the influence of temperature changes.

The grate does not as a rule receive the necessary attention and study to get the best results. Grate bars usually fail by twisting and warping from the unequal effects of the fire, thus causing one to rise above or sink below the others; the depressions so formed fill with ashes, and the elevations serve to collect clinker, the draft being thereby choked and fuel wasted. This unevenness is moreover a source of trouble when cleaning the fire, making this operation difficult if not almost impossible. Thin bars are conceded to be the best, but they are also the most liable to failure because of their thinness, therefore some provision must be made to keep them in proper position. This is usually accomplished by means of projections from the sides of the bars called "snugs," which are of proper size to keep the bars the right distance apart. The bars are generally cast in pairs so that the two bars with their proper spacings form one piece. There is, however, the disadvantage in having the bars cast in pairs that one bar may be in perfect condition but must be discarded because its mate has become deformed. The bars should be from ⅝-in. to ¾-in. broad on top and diminish to about one-half that thickness at the bottom to allow free escape for the ashes and thereby prevent clogging and shutting off the supply of air. The entire area between the bars should equal from 35 to 50 per cent of the grate area. The grate area should be ample, as it is much easier to reduce, by bricking in, than it is to enlarge the area. If the distance from the fire doors to the bridge wall can be kept down to 6 feet, so much the better, as it will be easier to throw coal to the back of the grate. The height of the boiler above the grate should not be less than two feet; more is better, and some consider as much as four feet to be desirable. The ash pit should be at least two feet deep below the grate and is sometimes made water tight, in order to hold water which is supposed to prevent clinkers forming.

It can not be too strongly urged that the water be supplied to the boiler by two ways; these are usually a pump and an injector. This is a precaution against disaster by an accident to one or the other. The method of introducing the feed water into the boiler that seems to find favor with most engineers is the one where the feed pipe enters the front head about level with the top row of tubes and passes to within 12 or 15 inches of the rear and, turning, follows the side of the boiler to the bottom, where it ends in a tee; by this arrangement the water, having to pass through the length of pipe in the boiler, is heated almost to the temperature of the water that is already in the boiler, and it is discharged into contact with the boiler at about the coolest part. In addition the feed pipe being located in front of the boiler, it is more accessible in case of accident to it, than it would be if located at any other place. It should be equipped with a check and globe valve, of course.

Every one who has to do with boilers knows that scale is one of the worst enemies to be met, but few realize the benefit derived from clean boilers. Experiments have been made to prove that scale is not detrimental to the steaming efficiency of the boiler, but the experiments were conducted under conditions so entirely different from those existing in a boiler when working under pressure that the results do not prove anything that could be taken as conclusive. The various experiments made to prove that scale is detrimental furnished results so nearly uniform that it is easy to believe them. These results show that about 1/16 inch of scale requires that about 15 per cent more fuel be burned to do the work than if the boilers were perfectly clean. The percentage of extra fuel increases as the thickness of scale increases. Experience proves that in some railroad works locomotives having been run some months require to have the load cut down and if run without cleaning for a short time longer are apt to "lay down" on the road. A continued use results in retubing the boiler; this course occupies less than one year's time, and is due solely to poor water and the resulting scale. Scale also causes bagging of the boiler shell; the scale prevents the water coming in contact with the iron and allows it to become heated to a dangerous point.

The boiler is not the best place in which to precipitate the matter held in solution in the water, and expensive water softening systems are not available for every plant. There is one apparatus, however, that has proved very efficient, and not very expensive, for the purpose of preventing the collection of sediment, and formation of scale in the boiler. This apparatus consists of a skimmer or funnel located inside the boiler, pretty well toward the rear and facing the front; it is placed so that the mouth extends partly above the water level. In the boiler there is continual boiling up of steam which keeps all the sediment for a time near the surface of the water; within the funnel or skimmer there is comparatively quiet water, and the scum or solid impurities collect there and sink to the bottom or neck of the funnel and from there are carried into a settling tank situated either behind or to one side of the boiler, through a pipe that enters the settling tank near the top and continues down nearly to the bottom. The water passing through this pipe does so at a comparatively high velocity which serves to carry the sediment from the boiler to the tank. The tank being very large in comparison to the pipe, the water while in it has little or no velocity, thus giving the sediment a chance to settle; when the water rises to a certain point in the tank where a return pipe is situated it returns into the boiler. The tank is equipped with a blow-off, through which the collected sediment may be blown out every day.

Kerosene is used to prevent scale, and, when used in small quantities, is highly recommended. It is usually introduced before filling the boiler with water, and as the water rises in the boiler it carries the oil with it, thus coating every part of the interior of the boiler with a thin film of oil. This prevents the new scale adhering to the metal, and gets under the old scale, loosening it and separating it from the boiler. About two quarts of oil per week for a boiler 48 inches in diameter by 12 feet long and about three quarts for one 60 inches in diameter gives the best results. Many of the boiler compounds or scale solvents sold are of a harmful nature, and the secret compounds should be avoided most carefully, as they generally consist of caustic soda or lime. It is usually lime, which is colored up in order to conceal its presence. Sometimes these compounds are adulterated with useless and harmful matter that should never be put into a boiler.

When it becomes necessary to clean a boiler it should be thoroughly cooled before anything is done. This may be accomplished by opening the fire doors and dampers, and keeping the flue doors closed; this arrangement permits a current of air to pass through the hot furnace, hot tubes and so on out through the stack. The air by coming in contact with the hot furnace and setting is fairly well heated by the time it reaches the tubes, as may be seen, the furnace and setting gradually giving up the heat that remains in them to the air become cooler, and the air is fairly warm by the time it reaches the tubes and the danger of the tubes being cooled down too quickly is avoided, as the setting and boiler cool down together. If the flue doors only are opened, the air will pass directly to the stack without having passed through the furnace or boilers.

When replacing manhole or handhole plates it is well to scrape the boiler at the place where the gasket bears; there may be some particles of the old gasket still adhering to the boiler shell and they will cause trouble by preventing the new gasket from seating itself, thus causing leaks. Before the new gasket is placed for the last time it should have a good coat of graphite;

this will prevent it sticking to the metal. Also, if the nuts are put on with graphite it will be found much easier to remove them, and the chances of twisting off a stud will be lessened.

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TELEPHONE CABLE DEPARTMENT ACCESSORIES.

BY CHAS. H. COAR.

Before entering into a description of the articles herein illustrated, it may be well to inform the reader that the efficiency of each article has been proven by actual usage.

The practical cable splicer knows how awkward it is to boil out a splice, especially aerial splices, when he has to hold his paraffine kettle in one hand and use the ladle with the other. The drip pan shown in Fig. 1 is so designed that it eliminates many of the difficulties attending the boiling out process. The pan, which should be made of galvanized sheet iron, is of somewhat similar shape to the rain gutters one sees on houses. A pan of the dimensions specified in the sketch is convenient, although the size could be altered to suit local requirements. The end pieces, *a*, are cut out in such manner that the pan may partly enclose the cable. The outlet, *c*, allows the drippings to flow from the pan. By placing a paper in the pan to prevent sticking, it will be useful also in catching the dropping solder while the joint is being wiped.

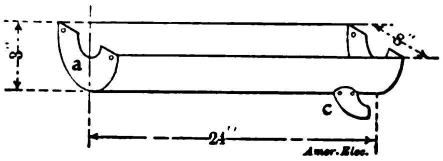


FIG. 1.—DRIP PAN.

In most boards for making cable forms an arrangement of pegs or nails is used to terminate the different wires. A board which has some advantages over this method is shown in Fig. 2. Instead of using pegs, holes are bored through the board. After the different wires are threaded through the holes, the form may be laced more readily than it could be with the arrangement of pegs, which would be in the way. By turning the board over, after the form is laced, the insulation may be peeled from the wires to a scale without altering the shape of the form. The size of the board would depend upon the form to be made on it, of course.

Fig. 3 represents a box for holding tags preparatory to marking the different wires of a cable, which presents some advantages over the old methods of stringing the tags together or hanging them on hooks which are fixed in a marked board. Tags strung together become twisted or mixed, and it takes but a small gust of wind to raise the tags from hooks.

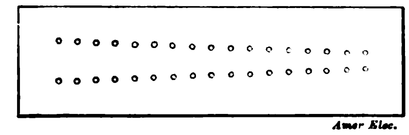


FIG. 2.—CABLE FORM BOARD.

The box here shown is constructed to hold a round tag, but the shape of the tag would not alter the box to any great extent. The backs of the two halves of the box, which are made of one-inch lumber, have grooves cut in them to a depth of half an inch, both lengthwise and crosswise, in such a manner that squares are formed as shown in Fig. 3. The grooves, *a*, running crosswise, are cut at an angle of 60 degrees with the surface of the board; in this way the inserted tags have a slant given them which enables one to readily pick them out. The grooves running lengthwise are cut perpendicular to the board surface and fitted with thin strips which divide the squares from one another. The squares may then be numbered as shown in the sketch, which represents a box having a capacity for 100 tags. The sides of the box are built of 1/4-inch lumber, which should be of such width as to form ledges at least 1/4 inch above the faces of the back boards. The two parts are hinged together so that they may be closed and prevent the loss of tags during transportation.

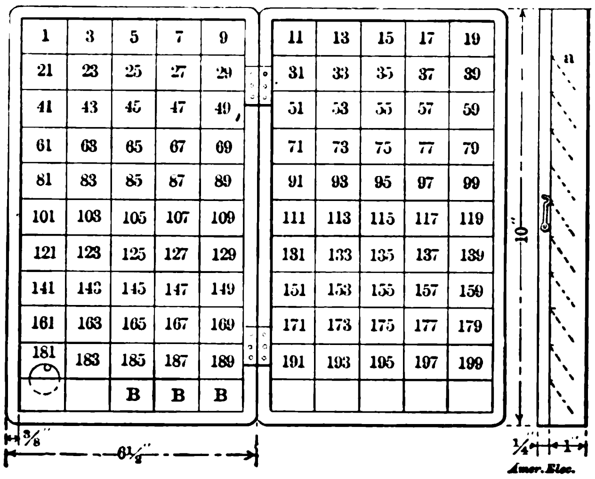


FIG. 3.—TAG BOX.

Some of the good features of this box are: (1) The tags are inserted at least half an inch in the slots, so that they are held firmly and protected at the same time; (2) as the box is numbered in rows of tens, one may easily locate the different numbers; (3) in case an error is made in picking out a number, it will be detected by the absence of a tag number; (4) all the tags are in sight.

A cableman's telephone circuit is shown in Fig. 4, in which *a* and *c* are five-point jacks; *b* and *d* are three-point jacks; *e* is a two-wire metallic-circuit plug connected to a head receiver; *f* is a two-wire metallic plug with flexible conducting cords which have snaps suitable for connecting the plug to telephone circuits handily; *G* is a bridging generator, and *B* is a 1000-ohm ringer. The plugs, *e* and *f*, are adapted to fit any one of the four jacks.

The operation of the set is as follows: By putting plug *e* in jack *a* and plug *f* in jack *b*, the set can be used to talk over either the magneto or central energy systems; but as the condenser is in series with the secondary coil one would not be able to raise the exchange in central energy systems with this arrangement of plugs. This would allow one to use a circuit in such systems without the knowledge of the subscriber or line operator.

By placing plug *e* in jack *b* and plug *f* in jack *c*, with the snaps on the wires of a line, one could call central and converse, using the line battery in a central energy system. It will be seen by tracing the circuits with this arrangement of plugs, that the receiver and transmitter are in series with each other across the line the set is being used on, and as the condenser is cut out, so to speak, one would be able to actuate the signals in central energy systems. This arrangement is also provided in order that the local batteries in the set may not be used when it is possible to use line battery for talking. By putting plug *f* in jack *d*, one could use the generator to call or a ring could be received. As the condenser is in series with the ringer, it could be bridged on a line in case one wished to receive a call, or it could be used to find ringing current upon any wire in this manner. The condenser prevents the ringer from short-circuiting direct-current circuits. The apparatus could be mounted in a convenient case in which a compartment could be provided for storing the head receiver and plugs. The case should be provided with a hinged door in order that the batteries may be readily changed. The transmitter might be set in a wall of the box with its mouthpiece flush with the outside of the case, like that of the old Blake transmitter.

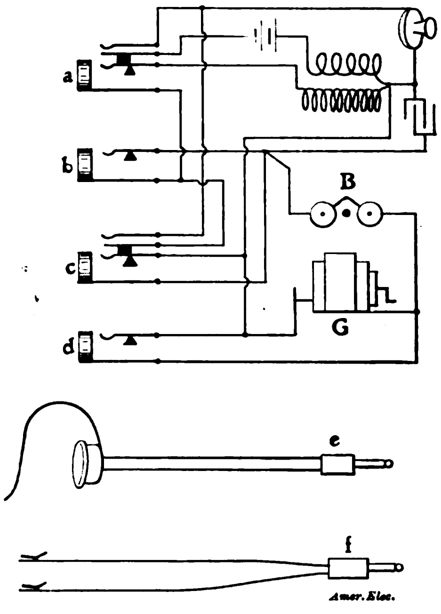


FIG. 4.—CABLEMAN'S TELEPHONE CIRCUIT.

Fig. 5 illustrates a method for testing out conductors in a cable which is applicable to both live and dead lines. The apparatus consists of a three-point jack, *g*, a five-point jack, *h*, a condenser, *k*, a singly-wound induction coil, *i*, with a vibrator, and the conducting cords terminating in a metallic plug, *j*. A common buzzer may be substituted for the induction coil, as the same effect could be produced with it. A local circuit, *L*, having a telephone at each end, is used to converse and receive the testing signals. The pair of wires to be tested is indicated by *T*. By placing the plug *j* in the jack *h* the vibrator is set in motion, which causes a pulsating current to flow in the battery circuit and charges the condenser, *k*, which discharges to ground over the conducting cords.

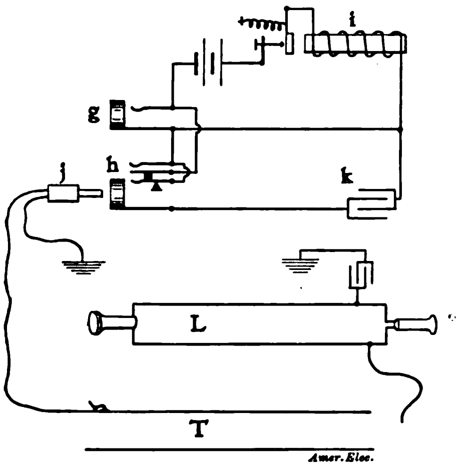


FIG. 5.—DIAGRAM OF CONNECTIONS FOR TESTING CABLE CONDUCTORS.

The operation is as follows: One conducting cord is grounded, and the remaining one is connected to the wire to be tested. The parties doing the testing are connected by the two telephones in the circuit *L*, one of which is grounded through a condenser, as shown. When contact is made with the line wire to which the conducting cord is connected, it causes the condenser discharges to flow through both telephones in multiple to reach ground. The parties doing the testing hear the clicking at the same time, so no delay is caused in changing from wire to wire in testing. While the set is connected to a cable just enough inductive reactance, due to the buzzer, will distribute itself throughout the cable to enable the man at the opposite end from the buzzer to tell when it is working. After one has become practically familiar with this method he can tell open or grounded wires by the sound received in the telephone. One may use this arrangement on lines having battery on them, as the condensers prevent grounding or short-circuiting. The set can be used to test fuses and for short-circuits by placing the plug in the jack *g*, which puts the batteries, buzzer and conducting cords in series.

By reference to Figs. 4 and 5, it will be noticed that the rest or under contacts of the jack springs are not used. The sets are usually subjected to hard usage, which would soon cause such connections to become faulty.

The writer is indebted to Mr. H. E. Thompson, who is the designer of the drip pan, form board and tag box, for information he has kindly given concerning them.

NOTES ON CONDUIT WORK.

BY ARTHUR B. WEEKS.

In conduit wiring, conduit boxes, such as the one shown by Fig. 1, are ordinarily used for receptacles, electroliers, or side wall brackets, fixture studs (Fig. 2) being used for brackets and electroliers. For switch boxes and drop lights on lamp cord, fixture studs are not used. When a fixture stud is to be used, it is usually fastened in the box by means of stove bolts, through the four small holes shown in Fig. 1; the nuts are put at the back of the box. Sometimes two bolts only are used. If the box is mounted on wood, stove bolts are not required, because screws answer the double purpose of securing the stud to the box and the box to the wood. When the box is mounted on brick walls, the wall is plugged, and the stud, if used, is not screwed into place; instead, large spikes are driven through at least two of its holes.

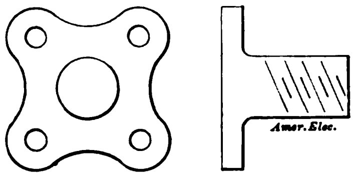


FIG. 2.

From ceiling outlets, fixture plugs must of course be used for fixtures. If the ceiling outlet box is to be also used for gas, the gas outlet is usually brought down through the center hole and the conduit enters any of the others, as is most convenient. When gas and electric light are to be used with the same fixture, an insulating joint must be used at the end of the short gas pipe which protrudes through the outlet box. Until the fixtures are ready to be installed, a cap is kept over this gas outlet.

Before putting up any boxes whatever, the exact location of all lamps must be known, the number of lamps, switches, and location of cabinets. The wireman is not bothered with these details, since they are previously marked out on the blue prints for him by the man who lays out the work. A red cross is made where outlets are to be put in, and an "S" marks the switches. Switches are easily accessible at 4 ft. 3 ins. from the floor. The right height for side wall brackets is about 6 ft. 2 ins. Lower than that, a bracket lamp does not give out much light, and is frequently in the way, causing the breaking off of the lamp socket stem. When the boxes are in place, the conduit must connect from box to box.

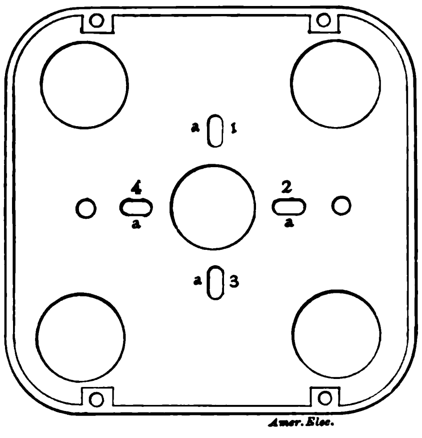


FIG. 1.

For drop cords from ceiling boxes, standard rosettes are used, to which the cords are attached. Fig. 3 shows a switch outlet box fastened to a piece of $\frac{7}{8}$-in. flooring lumber and located between adjacent studs of a wall at a convenient point near the entrance. The piece of flooring is nailed to the studding. In this illustration, it will be observed that the box cover has a rectangular opening, and that its longest measurement is vertical. This must be remembered when putting this box up for a switch, for the reason that the cover will fit only in one way. The conduit entering on the left at the bottom comes directly from the cabinet, or from another outlet. The pipe at the top in this particular case goes to a ceiling chandelier, and the switch in this box controls the lights in the chandelier. In some cases this upper pipe can make a direct run to the ceiling outlet, but again it may be necessary to go up through the floor, over, and down to the box. It is often found that conduit may be run between the joists and be fastened to the bridging by means of pipe cleats. The lower right hand conduit goes to a base-board receptacle on the farther side of the room, to be used for a portable desk light.

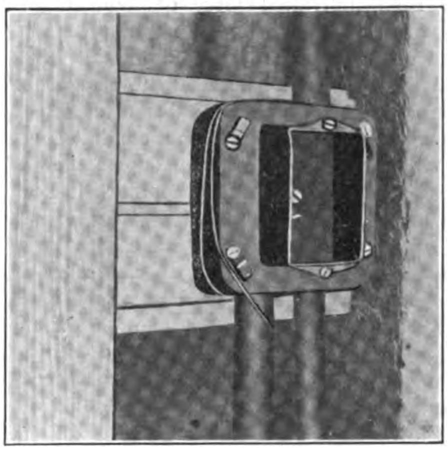


FIG. 3.

Where a rough flooring is used which is to be "furred," the conduit can be run on the floor. This is very convenient for construction work. The conduit should, however, be bent and so placed when meeting the floor line that it will not in any way interfere with the proper laying of the base-board and second or finishing floor.

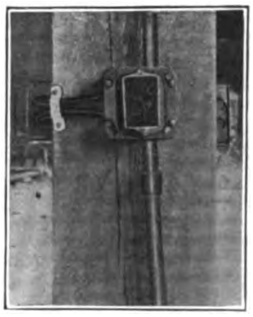


FIG. 4.

Fig. 4 shows a method of connecting outlet boxes on 10-in. posts for office use, for Zimdars & Hunt plug receptacles. Desks in the vicinity may be lighted by means of desk lamps in preference to the drop lights, if desired. Six feet above the floor is a box for a fan receptacle. The conduit comes directly from a cabinet and extends on up to the office floor above, to five outlet boxes like the one shown in this illustration. Conduit could not be used from box to box on the post, hence circular loom or alphaduct was used, fastened to the post by means of pipe cleats. The wire was pulled in each individual piece of loom before placing the final casing about the posts. In order to run vertical conduit in this manner, it is sometimes necessary to change the headers, as it is not advisable to cut them away. It is often best to run conduit down to the floor below and come up to the desired location, rather than approach it from above.

Figs. 5 and 6 show views taken in a large apartment block. In this special case, all partitions were made with 2 x 4's. It is necessary to know considerable about building construction in order to do wiring intelligently to any extent, especially conduit work. Horizontal 2 x 4's are laid directly on the floor, and the uprights placed upon them; horizontal 2 x 4's also extend across the upper ends of the uprights, along the ceiling. The conduit starts from the hall cabinet shown in the rough in Fig. 5. There are three distributing circuits from this cabinet, the feeder entering from the left. All pipes are kept between the studding and the bends at the baseboard are so made as to be concealed when the flooring and baseboard are completed. The first pipe on the left in Fig. 6 carries the feeder to the outlet box on the left; one branch is run on the rough floor to the opposite side of the room and up between the studding for a side bracket in an adjoining room. The other branch leads horizontally over to another outlet box, as shown. From this box, the conduit is continued down to the floor, crossing a vertical 2 x 4 which has been previously notched to receive it, as shown, and terminates at a baseboard receptacle in the next room at the right. The cover of this box must be flush with the strip of wood which runs above it, technically termed a "ground." From this point, conduit is run along the floor and up to a side bracket, shown in the background of Fig. 6. It will be observed that in running the conduit from the left-hand box to that at the right in the foreground, the studding is cut to receive the conduit. One or two nails, set at an angle so as to lap the pipe, secure it properly.

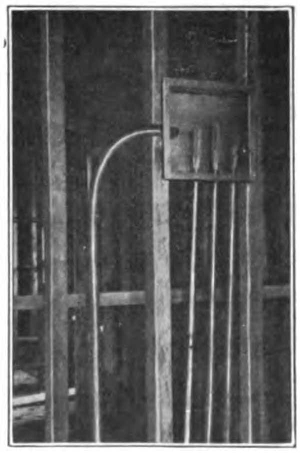


FIG. 5.

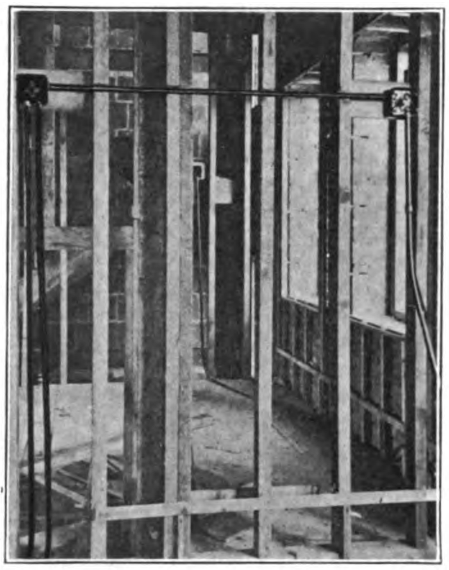


FIG. 6.

In all cases one must use ingenuity in conduit wiring to save as much pipe as possible. An unnecessary quantity can be heedlessly used by not carefully and intelligently mapping out the course of the circuits beforehand. Often expensive changes are made after the work has gotten well under way, when someone discovers a better method, or desires an outlet changed, etc. Changes in the original plan of wiring may sometimes be made necessary by alterations in the plasterers' plans; or a partition for a lavatory may be changed, or one put in so as not to include a light that was orginally included. This condition of things can be avoided by having the work under the charge of one man responsible for the whole. Changes made in this way lead to bad results, where the electric contractor is not informed of them in advance. If the building is being wired for conduit, it is of course desirable to finish all plastered work in this manner. Moulding on plastered ceilings is not very artistic, but is often made necessary, owing to a lack of foresight during wiring construction. Consulting the gas-fitter and carpenter will also save many changes to both parties. If this is not done, the electrician is liable to be compelled to change his plans at considerable expense.

Outlet boxes are sometimes placed back to back on the same board in adjoining rooms. The plugs are of course knocked out beforehand, in order that connections may be made from one to another. Sometimes a brick wall has to be cut to admit the box, and has also to be cut for the conduit, up or down as the case may require. This is not necessary when the walls are sufficiently furred, as shown in Fig. 7. The boxes are first fastened in place to plugs in the wall, and the "furring" strips are marked and cut to allow the conduit to be connected to the boxes. Lock-nuts are always required on the pipes next to the box on the outside. Insulating bushings to protect the wires on pulling in are used inside the box, over the ends of the pipes which enter the outlet boxes, for a distance of about ½ inch. Burrs are cut off the ends of all pipes by means of a reamer used in a carpenter's brace.

The first thing to be done on beginning a new contract is to erect a bench of some sort, with a pipe vise, locating the conduit bender either on the floor or on some convenient post. An improvised conduit bender can be made by screwing a 1¼-in. tee on the end of a 4-ft. piece of pipe, and fastening this pipe in the vise; almost any desired angle may be obtained. It is frequently necessary to do more or less cutting of joists in order to bring an outlet box into the right position. Accuracy in locating the outlet boxes is necessary, and in the rough work of construction this point may be overlooked. When the walls are finished and plastered, boxes located unsystematically or out of line give a very bad appearance.

To locate the ceiling fixture outlet for a room containing only one, strike a diagonal between corners both ways. The intersection will be the center for the fixture. Drill the hole, locate the outlet box, and run the conduit accordingly. If there is a "bay" in the room, it will look best not to attempt to center the fixture with relation to it.

If from the nature of the construction, the conduit is not to approach the outlet box from the floor above, but is to be reached on the same floor, a plumb bob is needed. Drop this so that the bob comes over the marked spot. Locate the place on the ceiling and secure the outlet box in the most convenient manner.

It is of course necessary to first locate the risers. These may often be best run in conduit whether the other circuits are to be run in conduit or not. If the building construction will permit, the risers can be run so as to be entirely out of the way of everything. Should the building be of iron frame construction, the conduit feeders can be run to best advantage before any wood work is done, especially should the flooring consist of 2 x 6's placed on edge. The same holds true in regard to concrete flooring. Concrete, by the way, is a hard material to

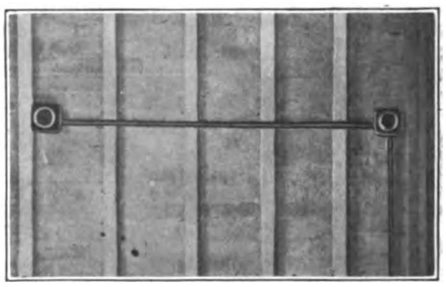


FIG. 7.

get through conveniently, to say nothing of the expense of tearing out and patching up again.

No specific rules can be laid out for all work. The accustomed plan to be followed for new work is as follows: Locate risers and cabinets first. Run to them with wire of sufficient capacity to allow for a certain drop, as previously arranged for. This will depend upon the conditions of service. If there are offices to be lighted, a small drop must be allowed, for a good light is needed for this purpose. If only mill work is to be planned for, a greater drop can be allowed. If the building is so laid out that one feeder must provide light for offices and mill combined, the wiring should be such that the offices will be first provided for.

Having located the outlets in the various rooms, start as many men to putting up boxes as can properly be provided for. Next put men at work putting in conduit. Cutting and drilling may be a part of their work also. Where bends in conduit are at right angles, the work is quite simple; but if they are to be made at different angles, the work will not progress so rapidly. When everything is well under way, the force may be conveniently increased if desired; they can then work to better advantage; before this, men would be in each other's way, and find little to do.

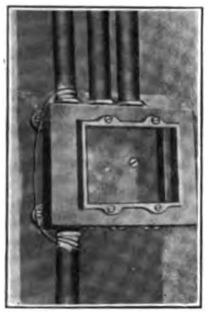


FIG. 8.

As soon as possible, pull in the feeders and risers. Run the feeders along joists in open work where necessary, to approach the conduit, using porcelain cleats even for very large wire. They are neater, and secure a better hold than tying to knobs. When the outlet boxes are all in place, put wooden plugs in the open ends of the conduits at cabinets, and stuff paper into outlet boxes to keep out plaster, etc. The covers must be put on before the plastering is done, with certain popular outlet boxes. It must be previously understood whether drop cords or fixture outlets are to be installed, and the box adapted to the class of work installed.

Provision is not always made for the location of the electric work; indeed, large buildings are often constructed without giving the matter any consideration whatever. Much valuable time is saved, however, by allowing places for electric mains and feeders. If baseboard receptacles are to be used, ascertain the location of the heaters, for they are liable to be placed directly in front of most of them. If receptacles are placed under the window frames, the cords would possibly have to drop down over hot coils of pipe, or be drawn up tight against them if pulled in back of them. Beware also of sliding doors which may cut off access also to baseboard receptacles.

All conduit should be perfectly grounded with bare copper wire before inspection. To do this, scrape the enamel off the pipe an inch back of the lock nut, on each pipe that enters an outlet box, and tie the bare wire, No. 16 or No. 14, secured around each pipe, as indicated in Fig. 8. Fig. 9 shows manner of approaching a cabinet from below. The center pipe is for the feeder, which continues up to the next floor to another cabinet. The cabinet on this floor is located in the clear space between the pipes. Part of the circuits are thus run from above and part from below.

Draw in the wire for the conduit when all plastering and other mechanical work is finished. If necessary, blow soapstone into the conduit first. A "snake" is then run through from one outlet to the next, and so on, leaving a loop as the work progresses. If there are several short bends, one will be unable to pull far, but must fish separately from box to box. The method commonly used in fishing the wire is to start at the cabinet and run in the "snake," after having bent the end into a loop with a pair of pliers if there is none on the end to be run in. (In cold weather the steel snake may snap in bending, unless the precaution is first taken to warm it slightly.) Insert this bent end into the conduit. It may meet with obstruction, but keep at it, and by examining the outlet boxes, its location will soon be found. Sometimes a change has been made in the work, but not on the blue print; as a result, the snake will not come out where it is expected. However, by examining the box to see how many pipes are connected thereto, some idea may be gained as to the change made, and where the wire should appear. Push the snake until it appears at the outlet, and fasten the wires to the other end of the snake. To do this, remove three or four inches of insulation, and secure the wire through a long flat loop at the end of the snake; tape the connection. Then pull the wire into the pipe and so continue, leaving loops as before. Use soapstone freely on the wire, to assist its going through the pipe.

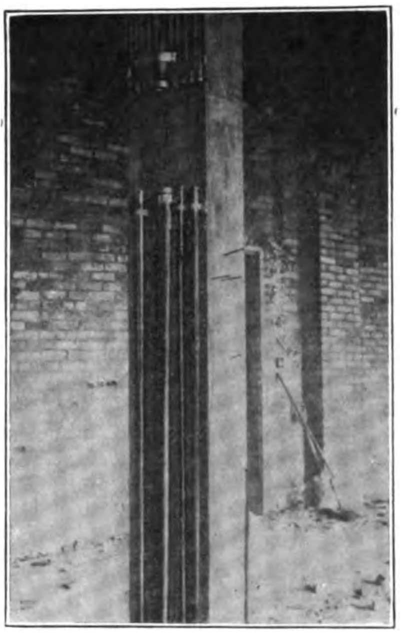


FIG. 9.

Lessons in Practical Electricity

REACTANCE. — IMPEDANCE. — ANGLE OF LAG. —PHASE DIFFERENCE.

In the December (1903) Lesson it was explained that when a current is first set up in a conductor, there occurs "self-induction" due to the "cutting" of lines of force by the conductor itself as the lines expand from the center outward; also that when the current ceases there again occurs self-induction, this time due to the collapsing of the lines of force set up by the current and therefore producing an impulse of e.m.f. of contrary sign to the impulse first produced. When a conductor is traversed by an alternating current, this phenomenon of self-induction is continuous instead of momentary, for the reason that the lines of force surrounding the conductor are constantly expanding and collapsing, under the influence of the constantly varying current. As the current rises in the positive direction, let us say, the magnetism increases in, say, the clockwise direction about the conductor; after the current passes maximum and begins to decrease, the lines of force commence to collapse, reaching zero value when the current reaches zero; then when the current rises in the negative direction, the magnetic lines expand in the counter-clockwise direction, and so on. The result is that the e.m.f. of self-induction, instead of being momentary, as when current is sent through a conductor or taken off, is always there, but varies in value like the applied e.m.f. and the current. It does not rise and fall in unison with either the applied e.m.f. or the current, however, but lags behind the current exactly a quarter of a cycle. The reason for this lagging will be apparent upon consideration of Fig. 1, where the two sine curves represent the rising and falling values of the current and the e.m.f. of self-induction or reactive e.m.f. The value of an induced e.m.f. is proportional to the rapidity with which lines of force are "cut" by the conductor, and as the lines of force vary most rapidly when passing the zero point (changing from positive to negative, or *vice versa*) the induced e.m.f. is maximum at that moment. When the current, and therefore the magnetism, is at the maximum value in either direction, its strength varies very little within a given momentary period of time, and consequently the induced e.m.f. is minimum at the moment the current and magnetism are at maximum; minimum is, of course, zero in this case.

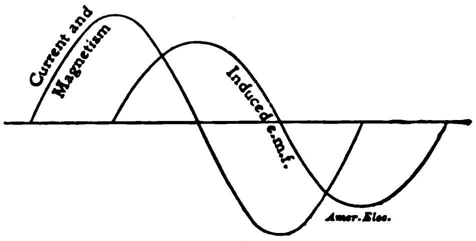


FIG. 1.

The relation between the rise and fall of the applied e.m.f. and that of the reactive e.m.f. of a circuit depends upon the relative values of the two, and also upon the resistance of the circuit. The value of the reactive e.m.f. depends upon the frequency of the current, since this determines the rapidity of cutting the magnetic lines of force, and also upon the strength of the current, since this determines the number of lines of force set up. The formula for reactive e.m.f. is

$$E_x = 2\pi f L I \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

in which f = the frequency in cycles per second,

L = the inductance of the circuit (see December Lesson),

I = the current in amperes (effective, not maximum).

The quantity $2\pi f L$ is termed *reactance*, the symbol for which is X; in formula shape, $2\pi f L = X$. It will be evident from the mathematical relation between inductance and reactance that the former, which is a property of the circuit, is independent of the frequency, while the latter varies directly with the frequency. A circuit may have inductance without being active, but it has reactance only when an alternating current passes through it.

Reactance is expressed in ohms, like resistance, because it constitutes an opposition to the passage of the current. Unlike resistance, however, this opposition does not entail any loss of energy because it is due to counter pressure and is not a property analogous to friction. Its effect in practice is to make it necessary to apply a higher e.m.f. to a circuit in order to pass a given current through it than would be necessary if only the resistance of the circuit opposed the current. The combined effect of reactance and resistance is termed "impedance" and is always represented in this country by the symbol Z or z. The impedance of an alternating-current circuit is

$$Z = \sqrt{R^2 + X^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

This will be recognized by students in geometry as the equation of a right-angle triangle, if Z be assumed to represent the hypothenuse and R and X the other two sides. This is merely a mathematical coincidence, however, resulting from the use of the sine curve as the basis of alternating-current calculations. It is the custom to represent the relations between resistance, reactance and impedance by a right-angle triangle for convenience in getting at other values; Fig. 2 shows the conventional diagram.

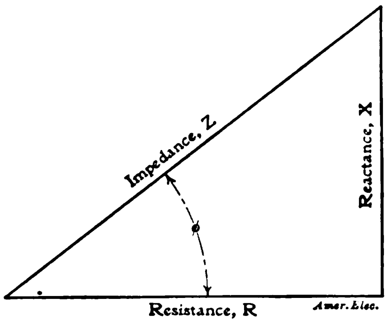


FIG. 2.

Since the impedance of a circuit is its total opposition to the passage of a current, the relation between the applied e.m.f. and the current in the circuit may be expressed by the formula

$$I = \frac{E}{Z} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The similarity between this and Ohm's formula will be apparent.

For convenience in computation, it is assumed that in inductive alternating-current circuits there are several distinct e.m.fs., the resultant of which is the applied e.m.f. It has just been explained that there is a reactive e.m.f. produced by the self-induction of the circuit; to overcome this and allow the current to pass, a component of the applied e.m.f is used up which is equal to the reactive e.m.f. and in direct opposition to it, of course. It may be represented by V_x. Another component is required to overcome the resistance of the circuit, and is equal to IR, the drop due to resistance, it may be conveniently represented by V_r. The relations between applied e.m.f., reactive drop in volts and resistance drop in volts may be shown by means of a triangle, exactly as in the preceding case, the only difference in the values being that all three of the former values have been multiplied by the current, so that the relations are unchanged. Fig. 3 shows the triangle of voltages; since $V_x = E_x$ and $V_r = E_r$, the formula may be written either

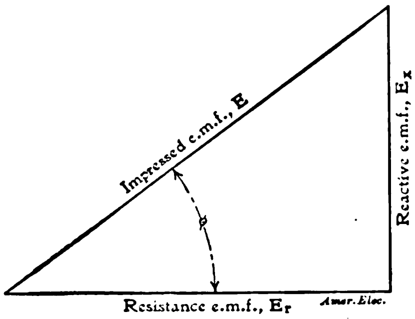


FIG. 3.

$$E = \sqrt{V_r^2 + V_x^2}$$

or

$$E = \sqrt{E_r^2 + E_x^2} \ldots\ldots\ldots (4)$$

It is usually written the latter way, and while this gives a numerically accurate result, it sometimes leads to confusion for the reason that E_r and E_x are not components of E, but are opposing e.m.fs.

It is customary to consider a cycle analogous to a circle, and to divide it into imaginary degrees; thus a quarter of a cycle is said to be 90 degrees, a half cycle to be equal to 180 degrees, and so on. This is convenient in that the lagging of the current and reactive e.m.f. may be expressed in degrees of a circle instead of parts of a cycle. Thus in Fig. 3, the angle ϕ between the lines representing impressed (applied) e.m.f. and resistance e.m.f. is said to be the "angle of lag" of the current in the circuit, the angle here being 53.13°; and the quarter of a cycle by which the reactive e.m.f. lags behind the current is referred to as "90 degrees," the line representing current and resistance making a 90° angle with the line representing reactive e.m.f. See Fig. 4. A further convenience results from this convention, namely, that trigonometry may be applied to the solution of alternating-current problems. Thus, the relation between the e.m.f. available for work and the impressed or applied e.m.f. may be expressed as follows:

$$E = E_p \cos \phi,$$

the subscript p being used to denote power. From this formula and formula (4) it will be evident that the e.m.f. available for work (or the e.m.f. to overcome resistance) is not the arithmetical difference between the counter e.m.f. of self-induction (reactive e.m.f.) and the applied or impressed e.m.f.

The proportion of a cycle by which a current lags behind an impressed e.m.f, or by which one e.m.f. lags behind another, is termed the *phase* difference; phase differences are always expressed as degrees of a circle; thus, in Fig. 3, the phase difference between the impressed e.m.f. and the resistance e.m.f. is the angle ϕ. As previously stated, this same angle is called the "angle of lag," but this term is usually employed only in speaking of the lag of a current behind the e.m.f. which is applied to the circuit; the term "phase difference," on the other hand, is generally used only in referring to two e.m.fs. or two currents which do not rise and fall in unison.

The fact that the component of the impressed e.m.f. that overcomes the reactance of a circuit and the component that overcomes the resistance are not "in phase" with each other leads to results which appear to be inconsistent to one in the habit of considering only direct-current circuits. In this latter class of circuit, the total effective resistance (corresponding to the impedance of an alternating-current circuit) is equal to the sum of all the separate resistances and counter e.m.fs., and the impressed e.m.f. is therefore equal to the sum of the e.m.fs. required to overcome these separate resistances and counter e.m.fs. individually. In an alternating-current circuit, however, this is not true, as the formulas just given clearly show. For example, if a circuit supplied at a frequency of 60 cycles contained a device the resistance of which was 10 ohms and the inductance 0.0796 henry, in series with another device of 30 ohms resistance and no inductance,

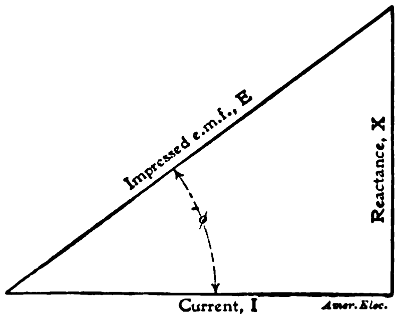


FIG. 4.

the total resistance would be 40 ohms, and the reactance would be $2\pi \times 60 \times .0796 = 30$ ohms. The impedance of the inductive device would be 31.623 ohms and the impedance of the whole would be $\sqrt{1600 + 900} = 50$ ohms; consequently, if the impressed e.m.f. were 100 volts there would flow a current of 2 amperes. Considering the two devices separately, the drop across the non-inductive device would be $2 \times 30 = 60$ volts, and the drop across the inductive device would be $2 \times 31.623 = 63\frac{1}{4}$ volts, the sum of the two drops being greater than the e.m.f. actually applied to the circuit. (See Fig. 5.) This seemingly paradoxial result is due to the two voltages being out of phase with each other, and consequently with the applied e.m.f.

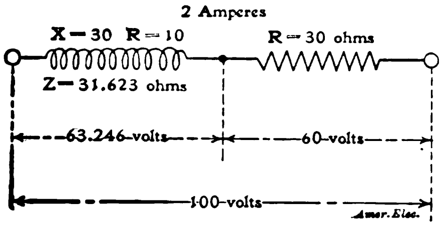


FIG. 5.

Letters on Practical Subjects

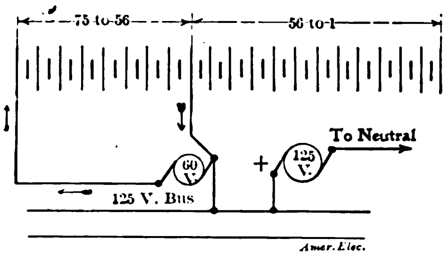
Operation of Batteries and Boosters.

To the Editor, American Electrician:—

I notice in my article on Operation of Batteries and Boosters in your January issue, a slight mistake. In Fig. 8, the arrows indicate a reversed direction of currest for the combination shown. A charge applied as arrows indicate in my sketch would reverse the cells instead of charging them. The accompanying sketch shows the arrows pointing in the proper direction.

W. T. FERNANDEZ.

Brooklyn, N. Y.



OPERATION OF BATTERIES AND BOOSTERS.

◆

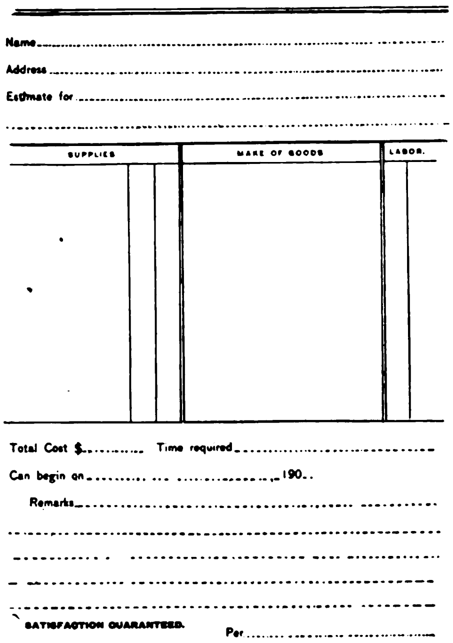
Convenient Estimate Blank.

To the Editor, American Electrician:—

Thinking that some of your readers who are engaged in the electrical construction and supply business might be interested in an estimation blank, I submit a sample of a blank form which has proved to be very helpful to both our customers and ourselves. board. Three points of attachment are pref- screws carrying the slate or marble panel When making an estimate for work or supplies, one blank is sent to the customer and a copy of it is kept on file in our office. This form of blank has proved to be very helpful in making estimates for small lighting plants and interior wiring. The actual size of the sheet is 5½ by 8½ inches.

E. S. LINCOLN.

Brookline, Mass.



Name..

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SUPPLIES	MAKE OF GOODS	LABOR.

Total Cost $.......... Time required..........................

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CONVENIENT ESTIMATE BLANK.

◆

Panel Boxes.

To the Editor, American Electrician:—

While the construction of panel boards approximates perfection panel *boxes* are, as one might say, still in the uncertain stage of existence. They linger along as a rough wooden box in various stages of incompletion through the early period of conduit installation. They must be lined with 1/16-in. iron or ⅜-in. slate, which must be ordinarily fitted, marked for the conduit and taken back to the shop to be drilled, or else hacked out on the ground in a very crude way. A casing or facing corresponding to the general trim of the building must be also made and lined with similar material. The whole operation is one of piecemeal construction at the building, at greater cost and with results far inferior to a design such as is here described.

The box proper is pressed up (or it may be lapped at the corners to save the cost of a heavy die) with full round corners from a single sheet of 1/16-in. steel. The bridges between the gutters and the panel box proper are all made by a single rectangular soft iron casting flanged at the back to facilitate riveting to the sheet steel box. The two corner lugs at the top and one in the center at the bottom are tapped for the screws carrying the slate or marble panel board. Three points of attachment are preferable so that the board cannot be sprung or strained by screwing down in case either the lugs or the board should be slightly out of true. This casting also has four arms extending sidewise as at *A*, Fig. 1, ribbed at the back for strength and furnishing points of attachment to the studding of the building. Ordinary flat-head screws may be used for securing the box, backed up with washers or a special screw by which it can be easily adjusted flush with the finished wall. Plenty of knockout holes are provided, which can be enlarged with a hand reamer for special location of mains. The whole cover of this box is cut from a single sheet of steel, the door being cut from the center piece to avoid waste. The outside, forming a cover for the gutters, is screwed on to the arms *A*, Figs. 1 and 2. Where no special finish is required this sheet metal door should be riveted to a ribbed cast frame for stiffening it and provided with hinges and spring catch. Ordinarily, however, it would simply be screwed to the back of the wooden door used for finish.

The conductors may enter the panel from the gutters through bushed holes or cast slots with well rounded edges as indicated at *B*, Fig. 1. The whole box should have at least three coats of thick enamel well baked in. This box is of standard width and is simply lengthened for greater capacity. Such a construction combines the lightness of wrought metal with the rigidity of cast metal, and requires the fewest possible number of joints and parts while affording a most convenient mode of attachment to the building. If any progressive contractor reading this will take the pains carefully to sum up the costs of the ordinary "installment-plan" box he will be surprised at the relative cheapness of this while its superiority will, I trust, be obvious.

ELMER E. WARNER.

New York.

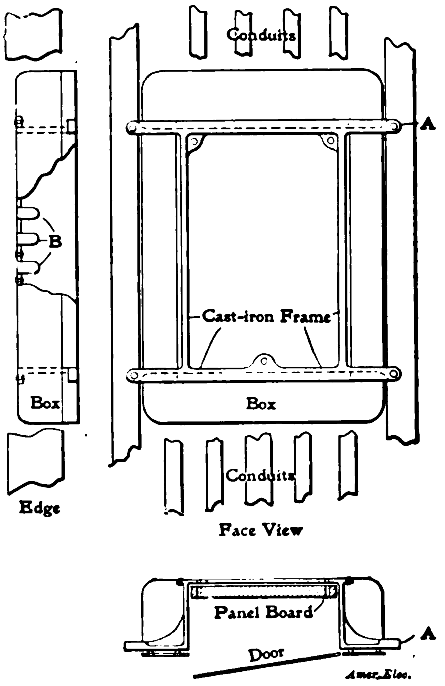


FIG. 1.—DETAILS OF PANEL BOX.

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

What should be the winding for the instrument described in the December number to make it a voltmeter indicating 20 volts at full scale?
O. S. D.

Wind the bobbin with No. 26 double silk-covered magnet wire to a depth of 1⅛ inches.

What is the difference between a gasoline motor and a gasoline engine? (2) Is gasoline ever delivered into the cylinder of an engine without first being vaporized?
K. W. E.

There is no difference. (2) We have never heard of an engine in which this is done.

An automobile battery is charged through a set of resistances from a 500-volt circuit at the rate of 8 amperes and the voltage at the terminals of the battery when fully charged is 106. For overcharging, 8 amperes is too much, but a 5-ampere rate is very effective. How much resistance will it be necessary to add to the circuit in order to reduce the rate to 5 amperes for overcharging?
G. J. P.

The additional resistance coils should have from 60 to 65 per cent of the resistance of those now used for charging. Connect the additional resistance in series with the old resistance and short-circuit it with a switch until the battery is fully charged; then open the switch for overcharging.

If the armature of a shunt-wound motor, which contains 8 turns per coil, be rewound with the same number of coils having 10 turns each, will the armature run slower or faster? (2) Will the loss in the winding be greater or less than that in the original winding? (3) What would be the difference in ampere-turns in the two windings?
C. F. K.

The armature would run slower; at no load the speed would be practically 80 per cent of the no-load speed of the original winding. (2) The loss in the winding will be 25 per cent greater than with the original winding for a given armature current. (3) The ampere-turns in the armature winding with a given load will be practically 25 per cent greater than in the original armature; consequently the tendency to sparking will be greater. The sparking tendency due to self-induction in the commutated coil will be about 25 per cent greater than in the original armature.

It is desired to install a three-phase generator having a delta-connected armature and to supply a lighting load from two collector rings only, until a motor load is obtained. What proportion of the rated output of the generator will be available for the lighting load under the condition specified? (2) If the generator is of 90% efficiency at full non-inductive load, what efficiency would be obtainable running it on the single-phase load as mentioned?
B. F. K.

If the heat losses were dissipated only by that part of the armature carrying the active winding, the available output would be 50 per cent of the rated three-phase output, but as the idle parts of the armature will undoubtedly assist in dissipating the heat the available output will be somewhat higher. (2) It is impossible to give a definite reply without knowing how the losses are distributed when the machine is operated three-phase. If one-half of the losses are in the armature winding, then the efficiency when operated single-phase, as described, would be about 86 per cent.

How can the resultant power factor at the junction of a feeder and two branch lines be ascertained if the power factor in each branch be known?
E. M.

The resultant power factor may be approximated with a sufficiently close approach to accuracy for all practical purposes by means of the formula

$$\frac{i' + i''}{\dfrac{i'}{p'} + \dfrac{i''}{p''}} = p,$$

in which i' is the current in one branch, p' the power factor in that branch, i'' the current in the other branch, p'' the power factor in that branch, and p the joint power factor at the junction. This formula is based upon the assumption that the current at the junction is the arithmetical sum of the two currents in the two branches, which is not strictly true because the two currents are not in phase with each other, and also that the actual joint resistance is the "equivalent" resistance, which is untrue; but the discrepancy is negligible in ordinary work and the error is usually in favor of the worker—it usually makes the power factor too low.

A metallic telephone line of galvanized iron wire, transposed at every second pole, runs for a distance of three miles on the same poles with a transmission line of 11,000 volts and 7 feet below the power line. Notwithstanding the transposition of the telephone lines, the induction renders conversation almost impossible. There are no transpositions on the power line. What remedy would you suggest? (2) Should a three-phase revolving-field generator make more noise in operation than a two-phase generator of the same speed and output?
E. W. B.

Two transpositions in the power line should improve the conditions; if these do not have the desired result, then the number of transpositions will have to be increased, but they should be made symmetrically so that the number of transpositions in the power line will be a sub-multiple of one less than the number of transpositions in the telephone line. Thus, if the telephone line contains N transpositions and N is an odd number (as it should be), the number of transpositions in the power line should be

$\dfrac{N-1}{x}$, x being any even number. If the number of transpositions in the telephone line is an even number, then the power line should have $N \div x$ transpositions. (2) Not necessarily. The humming of an alternator is affected by the frequency and by the shape of those iron parts of the magnetic circuit next to the air-gap.

Can four direct-current arc lamps, built to operate in multiple on a 125-volt circuit, be operated in series on a 500-volt circuit? (2) What is meant by the sparking constant of a generator or motor? (3) If two motors have power factors of 60% and 80% respectively and take 25 and 48 amperes respectively, what will be the joint power factor of the line to which the machines are connected? (4) Why does a wattmeter on a three-phase circuit give a negative indication when the power factor falls below 50%?
B. G.

Not unless the lamps are especially designed to be interchangeable between multiple and series circuits. (2) This is not a general term; it may be used by some designer to mean some numerical constant in a formula which is used as a criterion of the tendency to sparking. Different designers employ differeent sparking criteria. (3) See answer to E. M., and consider the two machines as the two branch circuits referred to there. (4) It does not necessarily do so. You will find this subject explained fully in Jackson's "Alternating Currents." Space limitations prohibit a full explanation here.

What is the working principle of the induction coil in a medical battery? (2) Why is the strength of the coil changed by changing the position of the core? (3) How can the locations for belt holes in a floor be ascertained for a belt connecting a pulley above the floor with one below it?
D. E. H.

Most medical coils are provided with only a singe winding which is energized and de-energized by the action of the vibrator. Each time the circuit is broken the self-induction of the coil produces an impulse of high e.m.f. at the terminals of the coil. (2) Because the strength of the magnetic flux, upon which depends the strength of the induced e.m.f., is changed. (3) Drop a plumb-line from the face of the upstairs pulley to the floor, holding the line at the center of the pulley-face, and bore a gimlet hole through the floor where the point of the plumb-bob strikes. Then by means of the plumb-line, manipulated from a step-ladder downstairs, locate the point on the under side of the floor which is directly over the point on the downstairs pulley-face corresponding to that on the upstairs pulley-face from which the plumb-line was first dropped; bore a gimlet hole at this point. Representing the distance from the center of the upstairs pulley to the floor by h, the distance from the floor to the center of the downstairs pulley by H (both distances being measured perpendicularly), the distance from the first gimlet hole to the second gimlet hole by D, and the distance from the first gimlet hole to the center of the belt hole by d, the belt hole may be located by means of the folowing formula:

$$\frac{D}{1 + \dfrac{H}{h}} = d.$$

This, of course, is for one side of the belt. The hole for the other side can be located in the same manner by locating gimlet holes directly beneath and above the other sides of the two pulleys.

THE AMERICAN CROSSLEY GAS ENGINE.

The type of gas engine built by the well-known English firm of Crossley Brothers is familiar to all engineers interested in gas engine work in this country and Europe and has made an excellent record wherever it has been introduced. The rights to build the Crossley engine in this country have been acquired by Power & Mining Machinery Company, New York, successor to The Loomis-Pettibone Gas Machinery Company. Although the American Crossley engine embodies the principal fundamental features of the English engine, several modifications of details have been made, notably in the valve gear. The engine is of the single-acting four-stroke-cycle type and is built in single-cylinder, double-cylinder and four-cylinder units of from 50 to 1300 horse-power rated output. The maximum ability exceeds the rated ability by about 15 per cent.

The accompanying illustrations show a double-cylinder engine of the *vis a vis* type. The crank-shaft has a center crank and the connecting rods work on one crank-pin, one rod having a single box and the other a forked end and two boxes straddling the box of the first rod. The main bearings are carried in the side frames which are two heavy castings, the ends of which are bolted to the cylinders. Between the side frames there is a steel plate crank pit bolted on, which received the waste oil and the top is surmounted by a sheet steel oil guard. The cross-head pins are pressed in the connecting rods and work in adjustable bearings in the pistons. The pistons are water-cooled and provided with adjustable slippers, an important feature too often neglected in single-acting engines. The main cylinder casting which forms the water-jacket is provided with extensions and flanges on the sides for bolting to the side frames. On the bottom the cylinder has a foot held down by foundation bolts. The working cylinder proper is an internal liner ribbed around its circumference on the end exposed to the high initial temperature and pressure, thereby having great strength combined with ample cooling surface. The cylinder head is a hollow casting and contains the admission and exhaust ports. It is of varying thickness of metal cut through in places and strengthened by staybolts in such a manner that the difference in temperature at different points does not set up any undue stress due to unequal expansion. The exhaust valve box is an independent water-cooled casting bolted to the bottom of the cylinder.

The valve gear is driven from the main shaft by means of spiral gears and the side shaft *S*. The governor is also driven in this manner, but by an individual side shaft. The operation of the valve gear and governor mechanism at each end of the engine is as follows: The air and gas enter the mixing chamber, *M*, through a proportioning valve, as indicated in Fig. 2, the air entering the mixing chamber direct and the gas entering through a gas valve, *G*, Fig. 5. From the mixing chamber the air and gas pass to a cut-off valve, *C*, and the main admission valve, *A*, Fig. 8. The admission valve, *A*, is opened by a cam on the sec-

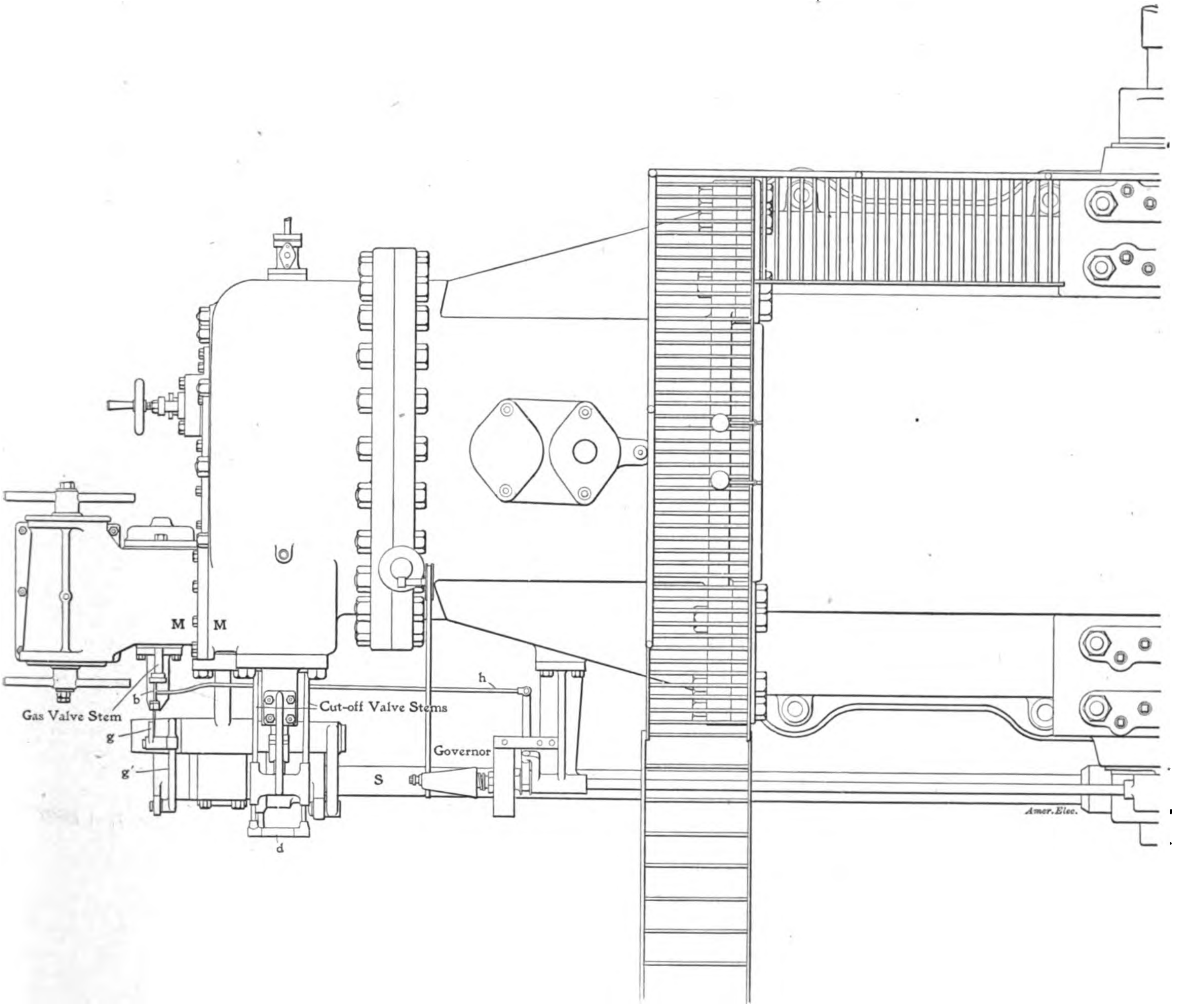


FIG. 1.—PLAN VIEW OF ONE-HALF OF A DOUBLE-CYLINDER ENGINE.

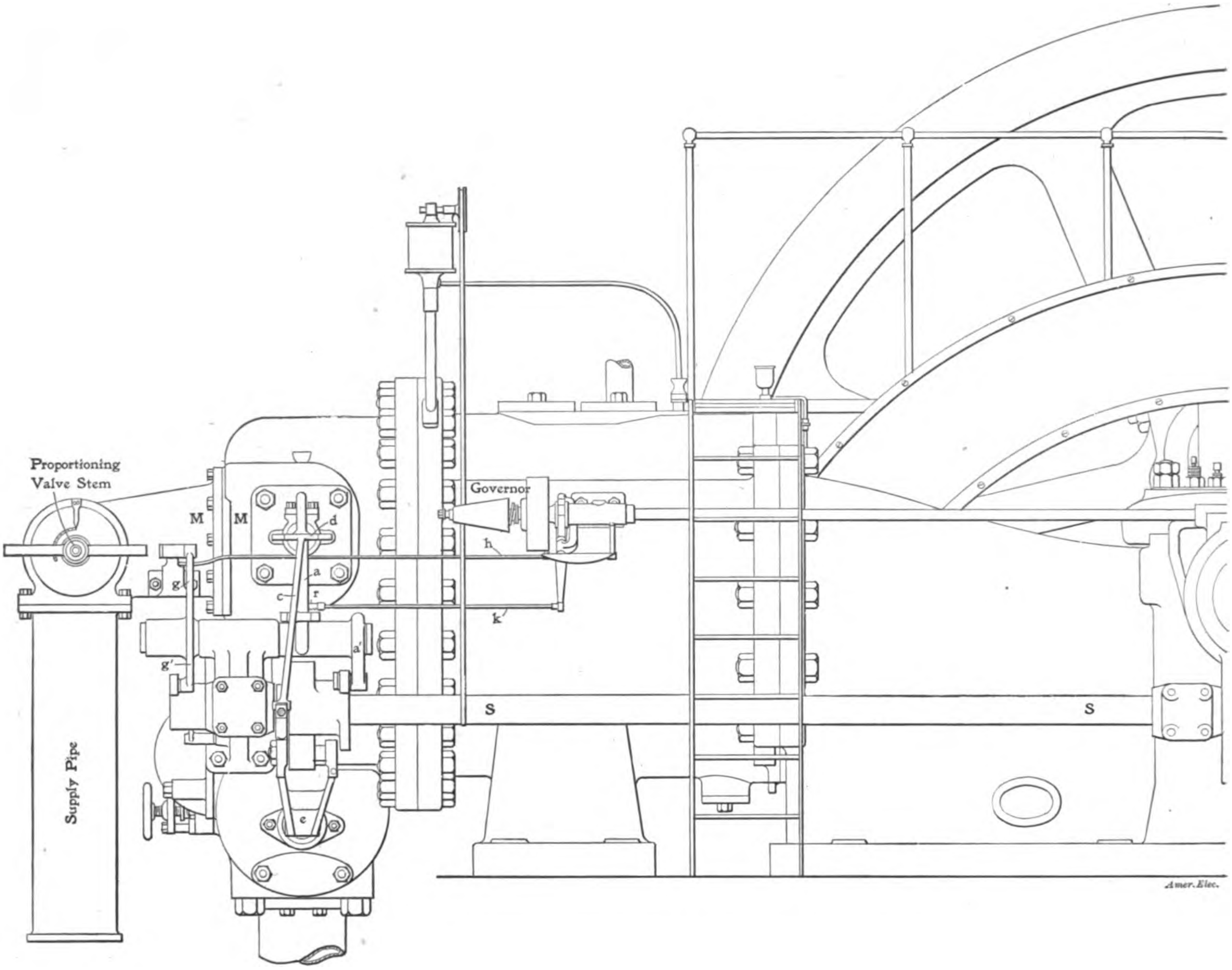

Proportioning Valve Stem
M
M
d
a
c
r
g
g'
a'
h
k
Governor
S
S
e
Supply Pipe
Amer. Elec.

FIG. 2.—ELEVATION OF ONE-HALF OF A DOUBLE-CYLINDER ENGINE.

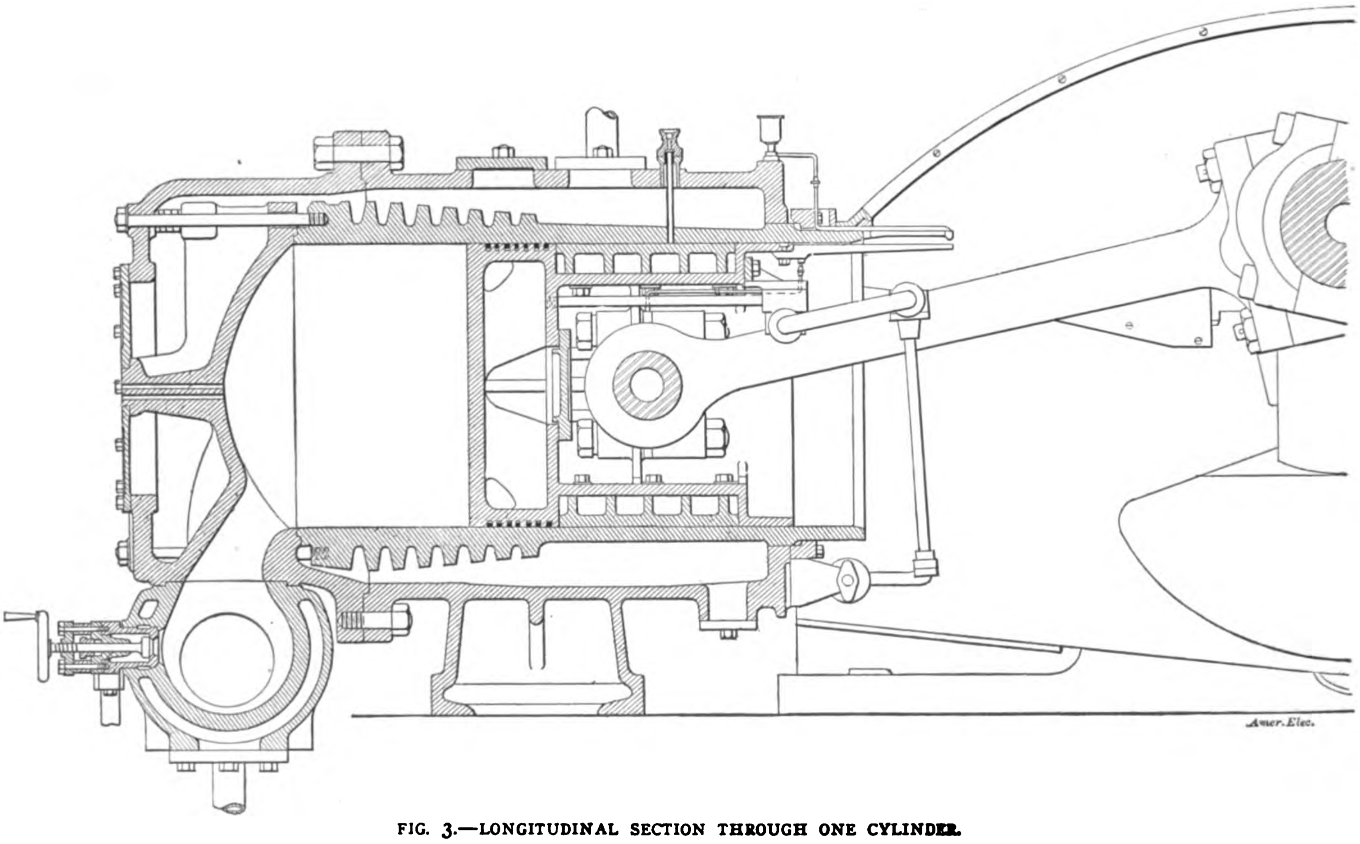


FIG. 3.—LONGITUDINAL SECTION THROUGH ONE CYLINDER.

ondary shaft, *S*, through a modified bell crank, *a*, *a'*, and is seated by the spiral spring shown in Fig. 8 surrounding the valve stem. The cut-off valve is of the multiported type and is operated independently of the admission valve by means of a rocker-arm, *c*, Fig. 5, which is fulcrumed at *f* and receives its motion, of course, from the secondary shaft. Fig. 7 shows a plan view, to a larger scale, of the admission and cut-off valves, from which the arrangement of the valve spindles will be obvious. The head of the admission valve rocker-arm, *a*, Fig. 8, works between the end of the valve spindle and the cross-head, *d*, attached to the twin valve stems of the cut-off valve.

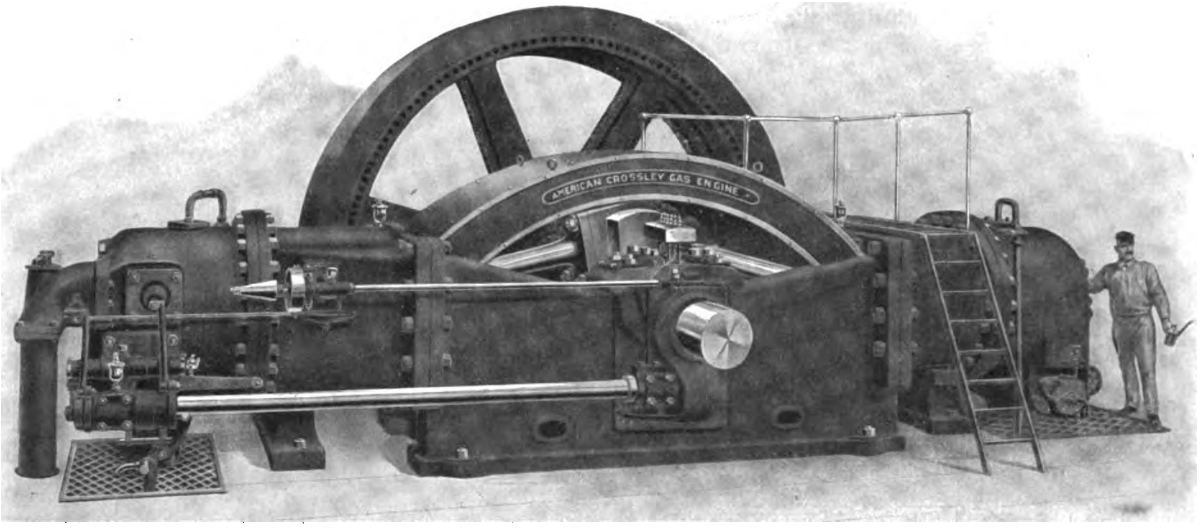


FIG. 4.—650-H.P. AMERICAN CROSSLEY GAS ENGINE.

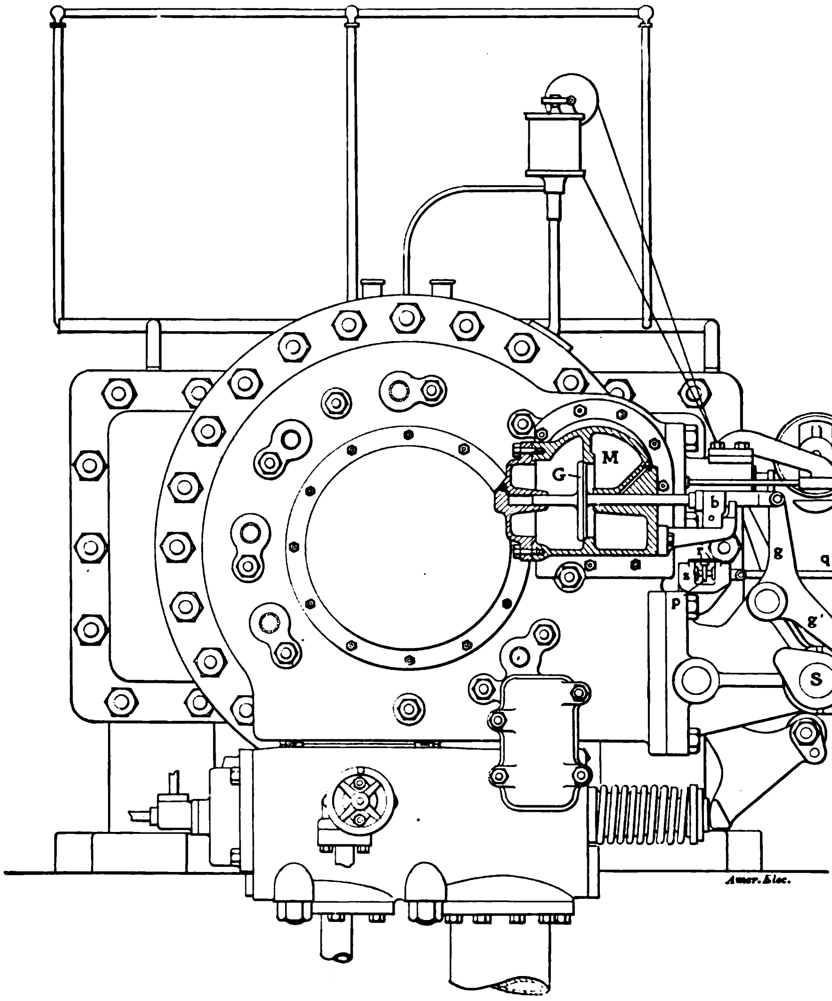


FIG. 5.

So long as the load on the engine remains constant, the cut-off valve shuts off the supply of mixture at the same point in each suction stroke. Should the load change, the altered speed of the governor will move the rod, *k*, Fig. 2, by means of the rack, *r*, and the pinion, *p*, will turn the screw, *s* (see also Fig. 6), and thereby move the rod, *q*, in or out according to the requirements of the case, changing the position of the fulcrum, *f*, Fig. 5, and altering the point of cut-off. This method of regulation controls the speed of the engine throughout the ordinary range of loads, but when the load becomes light enough to make the throttling method of regulation uneconomical the engine automatically changes over to the hit-and-miss method.

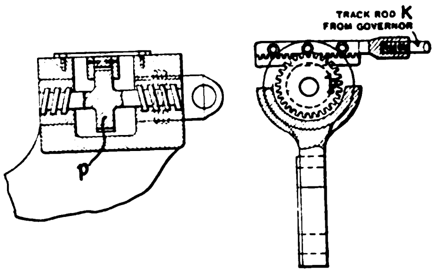


FIG. 6.

The bell crank, *g*, Figs. 1 and 5, operates the gas valve, *G*, through a block, *b*, interposed between the link pivoted to the crank arm *g* and the end of the valve stem. At a predetermined light load, the governor, by means of the reach-rod, *h*, Figs. 1 and 2, withdraws the block, *b*, from its operative position, so that the gas valve remains closed. The admission valve, however, is operated as usual, so that the cylinder is flooded with air. The point where the change is made from regulation by cut-off to hit-and-miss regulation is determined in

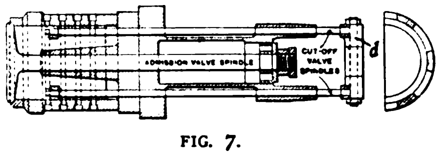


FIG. 7.

accordance with the quality of the gas and by adjusting the length of the rod, *h*.

The weight of fly-wheel necessary for good regulation at full load has been found sufficient to effect good regulation with the hit-and-miss method of governing at the smaller load which the engine is carrying when this method comes into play. The combination of the two methods of control reduces very greatly the range of variation in compression under varying loads, and therefore holds up the economy of the engine at these loads where it would otherwise drop to the rather low figure characteristic of throttling engines.

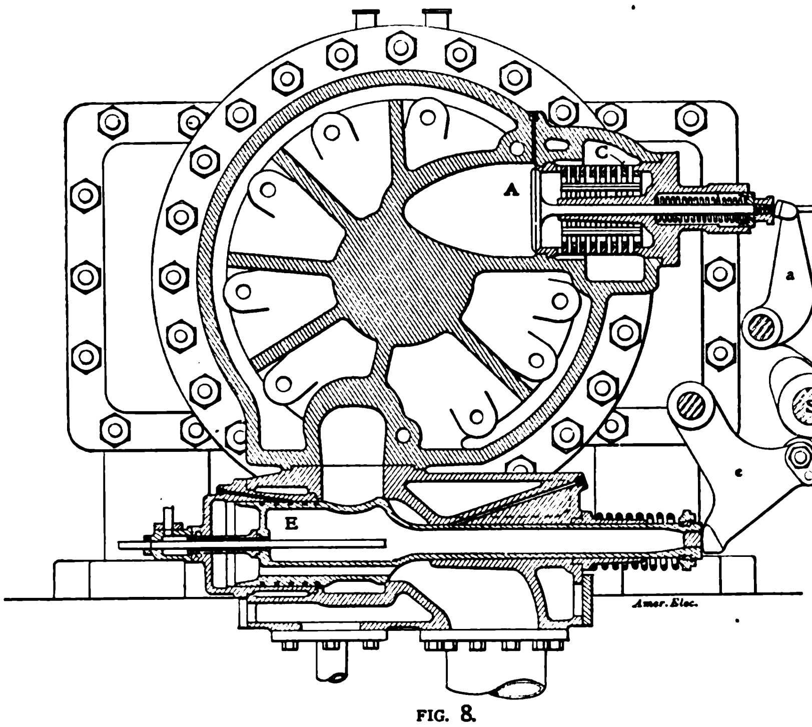


FIG. 8.

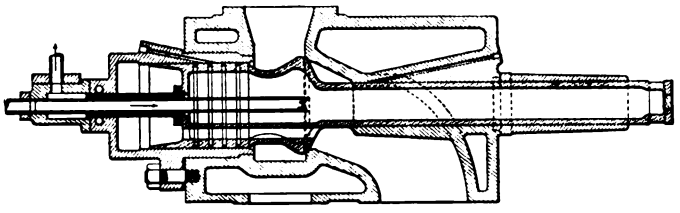


FIG. 9.

The exhaust valve, *E*, Fig. 8, is operated in the usual manner by an oscillating arm, *e*, receiving motion from the cam on the secondary shaft, *S*. This valve is shown to a larger scale by Fig. 9 and embodies the unusual feature of internal water cooling. The valve and stem are hollow, and water is delivered to the interior through the small pipe at the left, as indicated by the arrow. From the inside of the valve, it passes out again around the outside of this small pipe through the exit shown at the extreme left of the engraving. The valve is of the poppet type and the relation between the valve and its seat is the same as in the ordinary mushroom form of valve. It has the unusual advantage, however, of traveling in double guides, one on each side of the exhaust outlet, so that the pressure within the cylinder cannot throw the valve out of alignment with its seat. As Fig. 9 clearly shows, facilities are provided for lubricating both the vaalve-stem guide and the valve-shell guide. The exhaust-valve chamber is a separate casting bolted to the under side of the cylinder and can be taken off without disturbing any of the other working parts of the engine. Fig. 10 shows an indicator diagram taken from a Crossley engine fitted with the type of valve gear just described.

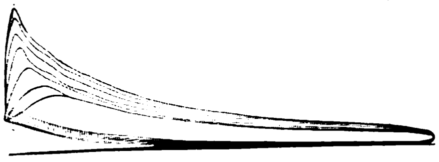


FIG. 10.

* * *

A NEW OIL-BREAK SWITCH.

The value of oil as an insulating and arc-suppressing medium in high-tension current interrupting devices used where space is a factor is universally known, and the equipment of the modern central station usually contains apparatus of this kind. The Westinghouse "Type D" oil switch is a comparatively new addition to the line of oil-immerged circuit-breaking apparatus, and is said to have original features which are not embodied in other oil switches. It is made with two, three and four poles, single and double throw, in all capacities up to and including 1000 amperes and voltages up to 3300. The ultimate breaking capacity is given at 600 kilowatts for a single-phase line, 1200 kilowatts for two phases and 1000 kilowatts for three phases.

When used on a switchboard, the switch is mounted on the back of the panel with the handle projecting through to the front. As regularly made, the switch is designed for use on marble two inches thick, but by substituting shorter bolts it can be as easily mounted upon thinner panels. The handle of the double-throw switch is locked when the switch is open. Pressing a button in the end of the handle releases it and the circuit is closed by throwing the handle up or down.

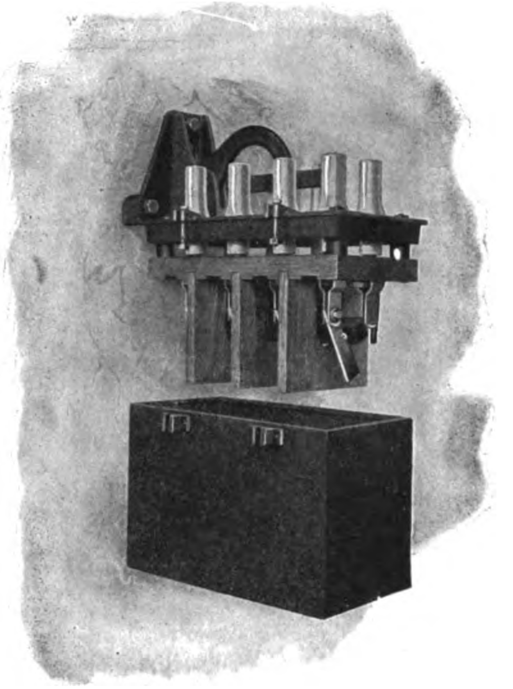


FIG. 1.—WESTINGHOUSE OIL SWITCH.

The "Type D" oil switch is very generally used with motors, mounted upon an adjacent wall or post. It is one of the smallest oil switches made, and the mechanism is said to be unusually simpe and effective. The switch is of the knife-blade and jaw type, and the final arc is taken up by an arc-

leakage distances have been carefully worked out, it is stated, and will be found to be ample. The contacts are thoroughly insulated; they are mounted on a wooden base suspended from the iron supporting frame, and are at all times immersed in the oil. Each pole is isolated by a barrier of wood which has been subjected to a treatment to give it high insulating qualities. The leads are brought out at the top, connections to the circuit being made inside the switch, and a porcelain insulator slipped over the joint; by this arrangement all conductors are kept outside the oil tank.

The tank is of sheet metal, having a suitable insulating lining and is attached to the case by bolts. The lugs through which the bolts pass are slotted, and when the nuts are loosened the bolts can be lifted out sidewise, thus facilitating removal of the tank. The form of the tank, and the interposition of the wooden barriers between the poles are said to reduce the amount of oil required and the danger of ignition during a fire. "Kilarc" oil is used; this is especially compounded for insulating purposes, and is said to have a fire test of over 400° F. It is claimed to be free from acidity and volatile matter, and therefore to have high insulating properties and a low evaporation rate, while its viscosity renders it unusually effective for extinguishing the arc.

New Apparatus and Appliances

NEW FUSELESS ROSETTE.

The rosette illustrated by Fig. 1 herewith is adapted particularly for concealed work. Ample room for the knot in the cord is provided in the dome which covers all contact pieces and the inside screws. The leading-in wires are separated by porcelain walls rendering short circuits impossible. The rosette is made by the H. T. Paiste Company of Philadelphia, Pa., and is suited for work on 250-volt circuits.

HIGH TENSION OIL FUSE.

A new oil fuse, simple in construction and especially adapted to high-tension circuits, is shown by Fig. 2 herewith. The device is made by the Anyun Lamp and Electric Company of Buffalo, N. Y., and consists of a glass tube with outwardly flanged ends, and a fibre cap at both extremities fastened to collars of similar material which are held in place by the flanges on the tube. Brass rods fastened to each cap hold the fuse wire, the latter being in the form of a link. The tube is filled with transformer oil to a point above the fuse wire, leakage of oil being prevented by disks and rubber washers, and when the fuse blows the oil fills the gap, thereby forming an effective insulation and preventing arcing. The following test which the manufacturers claim to have made in order to test the current capacity of the device is worthy of note: A piece of No. 10 copper wire was substituted for the ordinary fuse wire in the tube and the fuse short-circuited across a 2200-volt line with satisfactory results. The only part which is ordinarily destroyed is the fuse, and this can be readily replaced by another as often as the fuse blows.

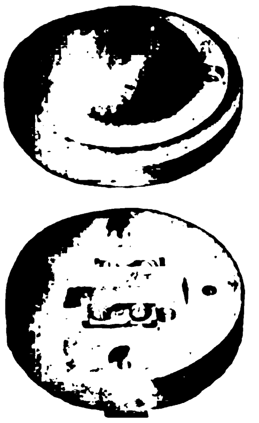


FIG. 1.—FUSELESS ROSETTE.

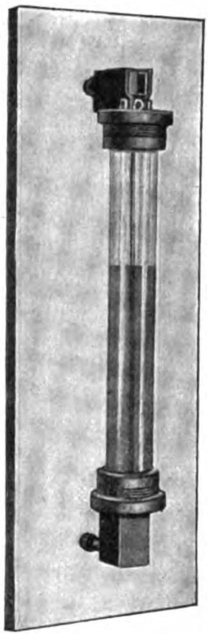


FIG. 2.—OIL FUSE.

MIL-AMPERE RULE AND CONSTANTNOMETER.

Figs. 3 and 4 herewith show the mil-ampere rule and constantnometer respectively made by Barnes Brothers, of St. Louis, Mo. Both instruments are arranged like stem-winding watches with glass-covered dials back and front, and operate somewhat after the manner of the Boucher circular slide rule. The constantnometer is used to ascertain the number of watts contained in any electrical horse-power by multiplying the number of electrical horse-power by 746. The electrical horse-power contained in any given number of amperes is obtained by moving the hand across the dial to the voltage desired and the constant will be found in the same scale. These constants are given in decimals and are said to be very accurate. Opposite them is the electrical horse-power.

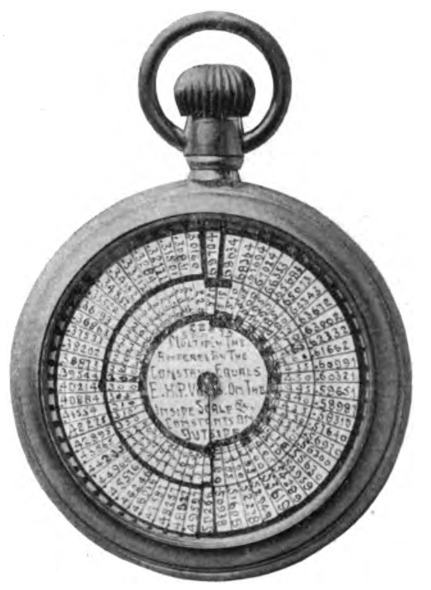


FIG. 3.—CONSTANTNOMETER.

The mil-ampere rule is said to contain all the information necessary for obtaining to carrying capacities of all sizes of conductors from 0000 to No. 22 B. & S. gauge, giving the current in amperes allowed by the National Board of Underwriters and also the circular mils of each wire. It is also said to contain the wiring rules and requirements for concealed and open-work wiring.

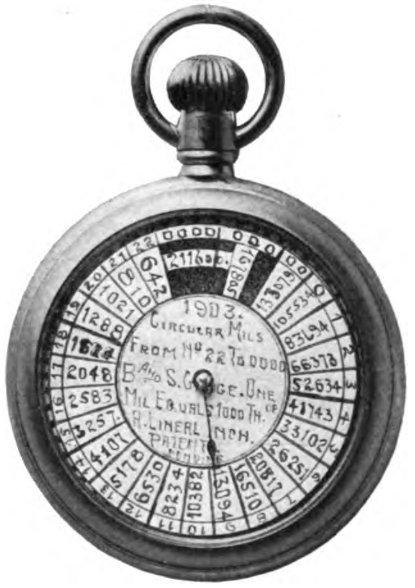


FIG. 4.—MIL-AMPERE RULE.

WATSON MOTORS.

In the line of large machines the multipolar motor with a form-wound coil armature has been standard practice for some time, but for machines of one horse-power and under this practice has not been generally followed. When the Mechanical Appliance Company, of Milwaukee, Wis., started to get out their line of motors they decided to take advantage of the benefits derived from a multipolar motor having a form-wound coil armature, and made their entire line from 1-8 horse-power up of this type. The frame of these machines is of cast-steel, the poles being cast as part of the frame and the larger sizes being provided with removable pole shoes. The bearings are of bronze with ring oilers, and are supported by cast-iron bonnets in such a manner that a good alignment is secured without the necessity of careful adjustment. The armatures are made up with a laminated slotted core, the discs making up the core being punched complete at one operation, thus making a core which requires practically no filing to finish it to receive the coils, and so maintaining the laminations intact and keeping down the core loss of the machine. The commutators are made up of segments punched from rolled strip copper, thus insuring a uniform width and density, and are insulated with mica. Before being turned the commutator is subjected to pressure, and the retaining screws drawn up while the commutator is hot, thus making the finished commutator rigid. The winding on the armature is made up of form-wound coils and insulated before being mounted on the core. After the coils are

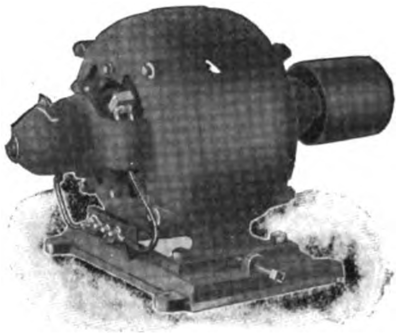


FIG. 5.—WATSON MOTOR.

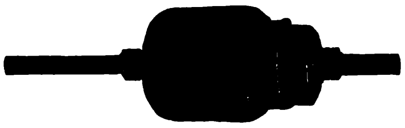


FIG. 6.—WATSON ARMATURE.

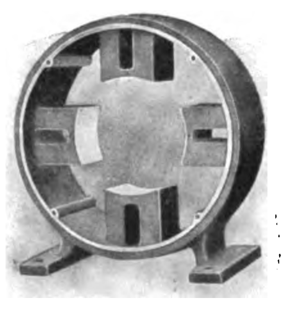


FIG. 7.—WATSON STEEL FIELD FRAME.

mounted the core and the coils are baked to dry them out thoroughly and are then treated with insulating compound and again baked for twelve hours.

THE LUNKENHEIMER METAL MELTING FURNACE.

Fig. 8 herewith illustrates the Lunkenheimer metal melting furnace, which has been found to afford a very efficient and economical method of melting metals, particularly brasses and bronzes. As shown, the furnace consists of a cylindrical sheet-steel drum, *A*, having cast-iron heads. The interior of the drum is lined with fire-proof tile, and there are two openings on opposite sides of the drum. Only one of these openings is in use, the other being closed by a fire clay filling. The object of having two openings is to increase the life of the linings of the furnace. It has been found that the furnace wears out uicker around the filling hole (which also serves as outlet for the flame) than elsewhere. An advantage claimed is that when one filling hole is worn out, this can be closed by a fire-clay filling and plate, the furnace reversed, and the other hole cut out and put in service. The oil burner is of special type, designed to give a great amount of heat with a minimum consumption of oil. Experience has shown that it is possible to secure from six to seven heats per working day of ten hours from each furnace. The weight of each heat will average about five hundred and fifty pounds, and the oil consumption, it is claimed, varies from two to two and one-half gallons of crude oil per hundred pounds of metal melted.

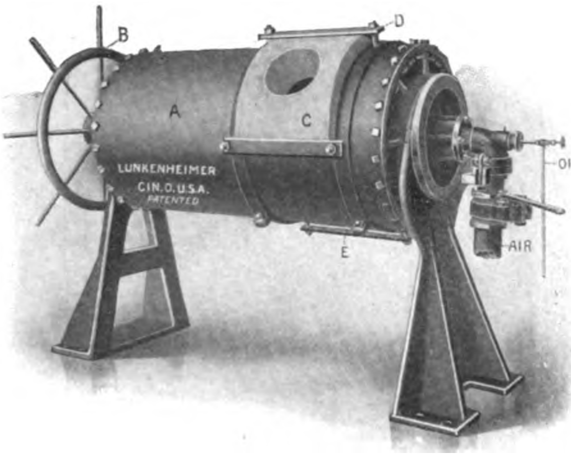


FIG. 8.—METAL MELTING FURNACE.

The life of the linings is said to be from three to four hundred heats, this varying with the kind of metal melted. The furnace is made in two sizes, one having a capacity of five hundred and fifty pounds of metal per heat, and the other having a capacity of twelve hundred pounds of metal per heat.

GENERAL ELECTRIC COMPANY'S CIRCUIT BREAKERS.

Three years ago the General Electric Company placed on the market a line of carbon break circuit breakers, which have given such satisfaction that the company has decided to extend and complete the line, by the addition of several new forms. This new line of circuit breakers is complete for all current capacities from 1 to 10,000 amperes, and for all voltages up to 650. The apparatus embodies many new ideas in circuit breaker construction, and is fully up to the high standard which characterizes all the General Electric apparatus.

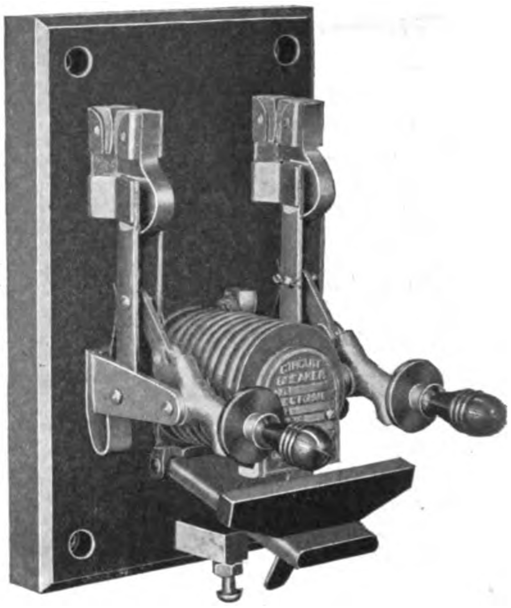
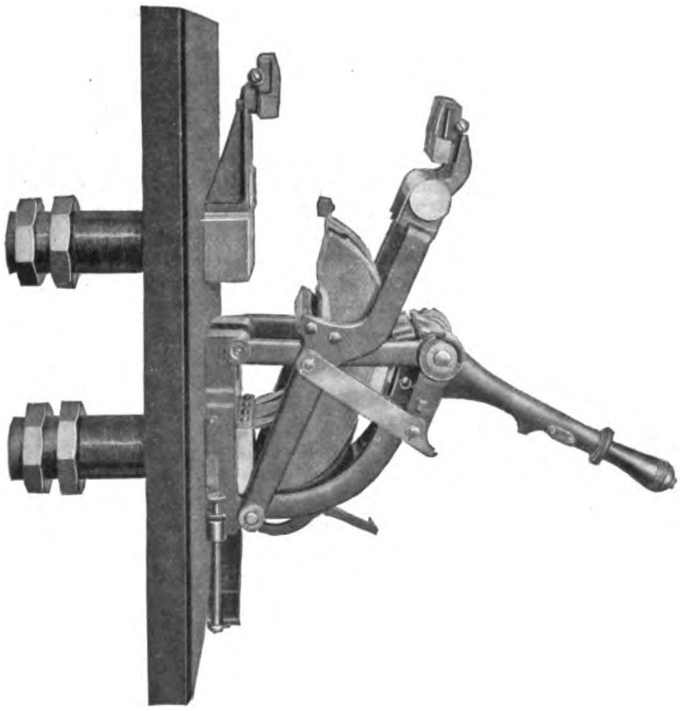


FIG. 11.—DOUBLE-POLE TYPE.



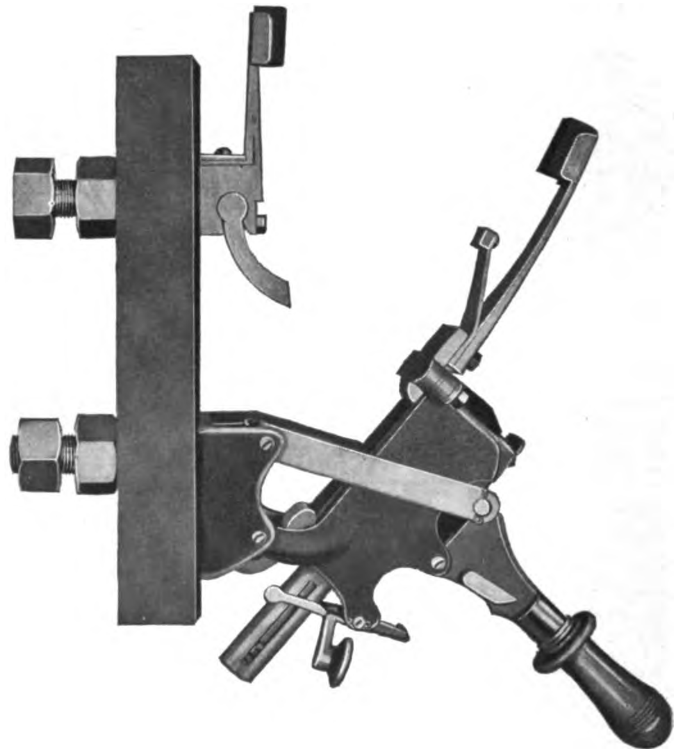


FIG. 9.—SINGLE-POLE RAILWAY CIRCUIT-BREAKERS.—FIG. 10.

The circuit-breaker illustrated in Fig. 9 is known as the Type "C," Form "K." This breaker is designed for heavy railway work, and is made in capacities from 800 to 10,000 amperes, and for voltages up to 650. It has been adopted by the Interborough Rapid Transit Company, of New York City, and other large companies for use in their power stations. These breakers are very liberally proportioned, both electrically and mechanically, having ample carrying capacity and large contract areas, and are said to be very reliable in operation.

The Type "C," Form "M" circuit breaker, which is illustrated by Fig. 10, like the Type

"C," Form "K," is intended for heavy service, but is of smaller capacity, ranging from 75 to 800 amperes. The Type "C," Form "G" circuit breaker which is shown in Fig. 11 is compact and simple, yet very reliable. It is made in various capacities up to 75 amperes, and for voltages up to 650 volts. This breaker is made in both single and double-pole types, and either pole of the latter may be operated independently.

MERIAM-ABBOTT GENERATING SET.

The Meriam-Abbott Company, Cleveland, Ohio, builders of small isolated lighting plants, are making a specialty of their 6-kw. and 8½-kw. direct-connected units. As shown in Fig. 12 these consist of a twin cylinder vertical gas engine, direct-coupled to a base type generator. Both the generator and sub-base are designed for connection to this particular engine, and a symmetry of design has been maintained throughout. In the construction of the engine the cylinders are separate, while the head is a common casting. Both the inlet and exhaust valves are located in the head and are not carried in cages. Great care has been taken to secure uniform cooling of the valve seats. The valves are operated by a cam shaft centrally located above the cylinder head. This shaft carries the cams which move positively both the inlet and exhaust valves, and at the forward end carries the make and break for the electric ignition. This shaft is driven by beveled gears from the governor shaft located at the rear and between the cylinders. The governor shaft is in turn driven by the engine shaft through beveled gears. The governor is of the simple ball type and is located on the governor shaft at the rear. It actuates a lever extending between the cylinders to the front, which in turn operates a six-ported piston valve. This valve requires less than 1/16 inch movement from no load to full load, and is very sensitive.

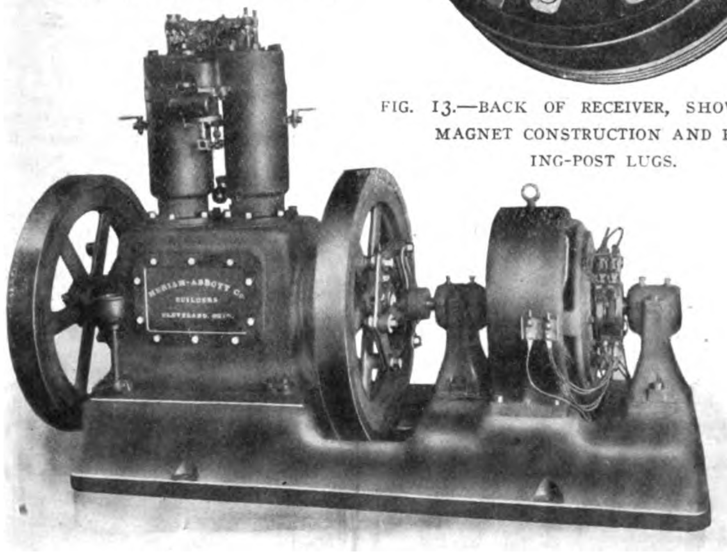


FIG. 12.—GAS ENGINE-DYNAMO OUTFIT.

Jump spark ignition is used. By this means there are no moving contacts within the cylinder and all parts are accessible. The current is supplied by three of the United States Battery Company's storage battery ignition cells.

The generator is coupled to the engine by a leather link coupling, so arranged that six links carry the load, and three links are used to take up the slack.

A NEW SOLID-FACE WATCH-CASE RECEIVER.

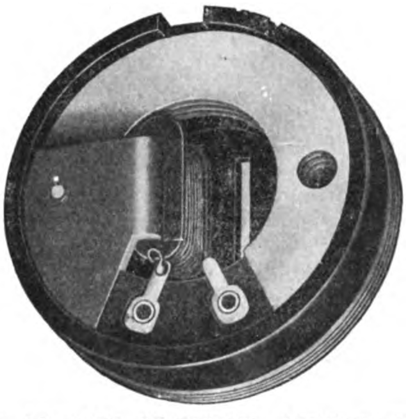


FIG. 13.—BACK OF RECEIVER, SHOWING THE MAGNET CONSTRUCTION AND BINDING-POST LUGS.

The Electric Gas Lighting Company, of Boston, Mass., has placed on the market a new solid-face watch-case receiver as a part of its line of "Samson" telephone apparatus. The case is a heavily moulded block, having a solid continuous face, with recesses in the back to contain the magnet and binding-posts. The metal back overlaps and strengthens the case, and is fastened to it by nuts. The back is insulated from the magnets and pole-pieces by the use of mica. The binding-posts are large and furnish good connection for the receiver tip. A low resonance chamber has been secured by the creation of an unbroken face, except where the pole-ends and binding-screws are brought through. This method of construction conceals and protects the magnet coil wires. The magnet is compound, having three laminations. The steel is made to carefully worked-out specifications, and is thoroughly hardened and magnetically saturated. The pole-pieces are fastened to the laminations so as to secure excellent magnetic contact.

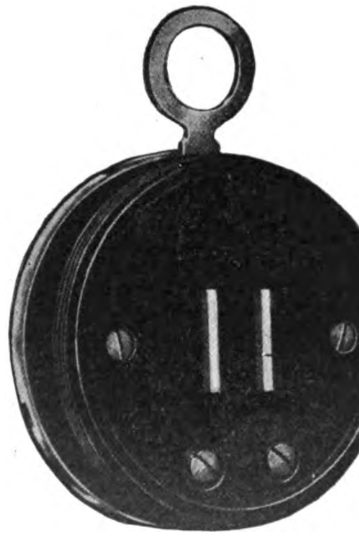


FIG. 14.—COVER REMOVED, SHOWING SHALLOW RESONANCE CHAMBER.

NEW BOOKS.

THE "MECHANICAL WORLD" POCKET DIARY AND YEAR BOOK. Manchester, England: Emmott & Co., Ltd.; 1904. Canvas; 267 text pages and 56 diary pages, 4 ins. x 6 ins.; illustrated. Price, 6d.

This is the 17th edition of this handy little pocket book, and contains a considerable quantity of new material. Weight-calculating tables have been added for steel, wrought-iron, cast-iron, gun metal, aluminum and lead, and tables giving the weights of bar copper per foot of length for a wide range of widths and thicknesses have also been added; the section on valve diagrams has been rewritten and elaborated and the new material further includes a table giving the calculated results for section moduli commonly used tables of stresses on bolts and steam and gas pipe fittings and formulas for bevel and spur gears. The gas engine section contains some interesting tables of dimensions relating to Fielding engines, and the section on oil engines contains similar tables relating to Crossley engines and some tabulated performances of Priestman, Hornsby-Ackroyd, Crossley, Premier and other oil engines.

FOWLER'S MECHANICAL ENGINEER'S POCKET BOOK. By William H. Fowler. Manchester, England; Scientific Publishing Company; 1904. Leatherette; 443 pages, 4 ins. x 6 ins.; illustrated. Price, 1s. 9d.; with leather binding and gilt edges, 2s. 9s. postpaid.

In this edition of Mr. Fowler's well-known Pocket Book the section devoted to the gas engine has been largely rewritten and considerably elaborated. Among the additions to this section may be noted a very convenient table containing constants from which one can readily ascertain the relation between compression pressure and the clearance volume. The gas engine section also contains a table giving the properties of one cubic foot of mixed coal gas and air for different proportions of gas to air, and the properties of the products of combustion of such a mixture, referred to the temperature of 32° Fah. Although no credit is given for this table, the reviewer recognizes it as having been taken from one of a series of articles written by the present editor of the AMERICAN ELECTRICIAN five years ago for *Power*. Following this section in natural sequence is a discussion of oil engines, which contains besides other useful information some data taken from a series of tests made with an 80-h.p., single-cylinder, Diesel engine, and a section on gas producers. The remainder of the book has not been greatly changed.

Fowler's Electrical Engineer's Year Book. Manchester, England; Scientific Publishing Company; 1904. Leatherette; 541 pages, 4 ins. x 6 ins.; illustrated. Price, 1s. 6d.; with leather binding and gilt edges, 2s. 9d.

This is a very complete little pocket book, and contains in addition to the material which was formerly included in the Mechanical Pocket Book also noticed in this column a large amount of other electrical information. The fundamental electrical and electromagnetic laws are of course, given, and there is the usual discussion of electric and magnetic circuits. Some of the magnetic permeability curves look as though they had been taken from Parshall's "Electric Generators," but no credit is given. The discussion of dynamo construction is unusually complete and accurate, but parts of the discussion have not been brought fully up to date, notably, the table on page 136 giving usual (?) dimensions of armature slots and the formulas on page 148 relating to sparkless collection. Incidentally, in the formula on the latter page purporting to give the limiting number of armature ampere-turns for multipolar machines the coefficient 288 should read 144 or else the symbol *P* should represent the number of pairs of poles instead of the number of poles. It is interesting to note that the chapter on storage batteries includes a brief discussion of the Edison nickel-iron element. The discussion of power measurement in alternating-current circuits might have been elaborated to advantage, and this is also true of the section on the size of conductors for polyphase transmission. The book contains, besides general fundamental data of the character mentioned, copies of the British Electric Lighting Acts of 1882 and 1888, and general particulars of the electric light and power stations and electric railways of Great Britain, which should be of value to British engineers; there are also some useful tables.

Friction and Lubrication. A Handbook for Mechanics, Superintendents and Managers. By William M. Davis. Pittsburg, Pa.: The Lubrication Publication Company, 1903. 225 pages; 60 illustrations. Price $2.00.

The book begins by stating the laws of friction as deduced by Morin, adding that these laws have been found by later investigations to apply only within a limited range of conditions. The treatment of the subject is elementary, but on the whole the statements are accurate. This cannot be said, however, of the definition of rolling friction, which is said to be "such as a journal revolving in its bearing, or a crank-pin in its brasses." There is a good deal of reliable information about lubricating apparatus for insuring the lubrication of particular machines, and also about the nature of lubricants. Under the heading of "Grease," however, the author quotes Mr. Charles F. Carpenter (who is, he says, a recognized authority on lubricants) thus: "In an oil the molecules are of a flexible spherical shape which revolve on and against each other, while in a grease they are irregular in shape, with no tendency to free movement." And all this time the rest of the human race has been fondly dreaming that the chief difference between oils and greases was that the former had lower melting points. Yet, when we think of it, we remember that some of the philosophers of ancient Greece (not grease) concluded that the bitter taste of certain substances was due to the fact that the molecules of those substances had hooks on them, and scraped the throat of the swallower as they went down. The poor overworked molecule, in addition to being absolutely rigid, as required by most molecular theories, must also, on occasion, be flexible; to say nothing of being "of a flexible spherical shape."

OBITUARY.

A. G. NICHOLS, president of the New York Safety Steam Power Company and also of the Langworthy Machine Company, died at Hope Valley, R. I., on January 13, after a short illness. Funeral services were held at Hope Valley on January 16.

HERBERT TAFT RICHARDS, late secretary of the Safety Insulated Wire & Cable Company, died in Brooklyn, N. Y., on December 26. Mr. Richards had a host of friends in the electric light and engineering fields, who will greatly mourn his loss. He was buried on December 28 from the home of his brother at Montclair, N. J.

W. O. GARRISON, president of the Columbia Incandescent Lamp Company, St. Louis, Mo., died on January 17. Although Mr. Garrison had been ailing for some time, his death was not expected and recovery seemed probable only a few weeks ago. The deceased was 42 years old, a native of St. Louis, and was officially identified with the Columbia Incandescent Lamp Company since January, 1891. He was prominent in both social and club circles. His brother, Mr. A. C. Garrison, succeeds him as president of the Columbia Company.

W. W. SKILES, president of the Shelby Electric Company, died in Shelby, Ohio, on January 9, at the age of 54 years. Mr. Skiles was one of the original promoters of the Shelby Electric Company, and was its president from the time of its inception until his death. He was also largely interested in many industrial concerns in Shelby. In addition to the business enterprises in which he was concerned, Mr. Skiles was senior member of the law firm of Skiles & Skiles, and also congressman from the Fourteenth Ohio district. He was buried on January 13. By his death The Shelby Electric Company loses a splendid adviser, who, although not actively engaged in the electric light line, had many friends among manufacturers and large consumers of lamps.

DR. FRIEDRICH VON HEFNER-ALTENECK, one of Germany's most distinguished electrical engineers, died early in January from an apoplectic stroke. Dr. Von Hefner-Alteneck was born in 1855 and was therefore 58 years of age. At the age of 22 he entered the firm of Siemens & Halske, having previously received his scientific training at the Zurich and Munich Polytechnics, and worked his way up into the position of manager of the engineering department, remaining with the firm until 1889. In 1872 he invented the drum armature, one of the most important developments in the design of dynamo electrical machinery. He also invented one of the first, if not the first, differential arc lamp, the transmission dynamometer which bears his name, and in 1883 the famous Hefner "Amyl-acetate" standard of light.

PERSONAL.

MR. R. H. MASON has been placed in temporary charge of the sales department of the Kellogg Switchboard & Supply Company, Chicago, vice Mr. A. E. Baker, resigned.

MR. J. E. WOODBRIDGE, of the railway engineering department of the General Electric Company, at Schenectady, has been transferred to the British Thomson-Houston Company, at Rugby, England.

MR. P. G. GOSSLAR, electrical engineer of the Montreal Light, Heat & Power Company, has resigned his position with that company and associated himself with the well-known engineering firm of J. G. White & Co.

MR. GEORGE W. EDGE, recently connected with Stanley & Patterson, has accepted a position with the Trumbull Electric Manufacturing Company, Plainville, Conn., as their representative in the Middle West and Eastern States.

MR. M. G. HUBBARD, for some time engineer and general superintendent of the McGuire Manufacturing Company, of Chicago, was recently elected secretary and treasurer of C. E. Hewitt & Co., engineers and contractors, of New York City.

MR. IRVING H. REYNOLDS, formerly of the Allis-Chalmers Company, and for many years identified with the design and construction of their engines, has accepted a position with the William Tod Company, of Youngstown, Ohio, as consulting engineer.

MR. SEWARD BABBITT, for a number of years sales agent for the William Tod Company, of Youngstown, Ohio, resigned his position on the first of January to accept a position with the De La Vergne Refrigerating Machinery Company, of New York City, where he will devote his time to the sale of the Koerting engine.

MR. W. J. JOHNSTON has sold to Mr. M. M. Swetland his stock interest in the Johnson Publishing Company which owns the *Engineering and Mining Journal*, and has severed his connection with that publication. Mr. Johnston will now devote his entire attention to the *Pacific Coast Miner*, which he bought over a year ago.

MR. E. STUTZ will lecture on alumino-thermics at the Massachusetts Institute of Technology, Boston, Mass., on February 25. Mr. Stütz is the American representative of the "Thermit process" controlled by the Chemical and Tin Smelting Works of Th. Goldschmidt, Essen-Ruhr, Germany, with offices at 43 Exchange Place, New York City.

MR. EDWARD N. LAKE, inventor of the Lake divided tile conduit, has accepted a position with the J. Lang Electric Company, of Chicago. Mr. Lake is well known among Chicago engineers, having been at one time chief switchboard draftsman for the Western Electric Company, and more recently on the engineering force of the Chicago Edison Company.

MR. N. S. BRADEN, formerly manager of the Westinghouse Electric & Manufacturing Company's district office at Cleveland, Ohio, has been appointed sales manager of the new Canadian Westinghouse Company, Ltd. Mr. Braden succeeds the late Mr T. C. Frenyear, whose death was announced in these columns last month. Mr. Braden will make his headquarters at Hamilton, Ontario.

DR. C. H. SHARP, engineer of the electrical testing laboratories of the Lamp Testing Bureau, of New York City, has returned from an interesting trip to Europe, where he visited all the principal electrical laboratories. Dr. Shrap gathered a mass of data and information which will enable him to fit up the new laboratories of the company, at Eightieth Street and East End Avenue, with the most complete and modern apparatus.

MR. W. S. MONTGOMERY, for many years secretary and sales manager of the Conover Condenser Manufacturing Company, of Jersey City, N. J., resigned his position with that company on the first of January to assume the management of the Payne Engineering Company, New York City, which is selling agent of the Payne Company, of Elmira, N. Y., builders of simple and compound automatic engines. Mr. Montgomery will locate in the Havemeyer Building, 26 Cortlandt St.

American Electrician.

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EQUIPMENT OF A LARGE FRENCH RAILWAY POWER HOUSE.

GENERATING STATION FOR THE PARIS METROPOLITAN ROAD.

BY C. DOMAR.

The plant erected in Paris to supply current for the lines of the Metropolitan underground system is one of the largest in Europe. The two sections now in operation are only a part of a great network of tunnels which will soon pierce the entire city. Work on the new sections is now in progress, and when completed, the eight sections will represent a total length of more than 40 miles of underground road.

The central station supplies current for the traction lines through a number of substations located along the road. Most of these are underground. That part of the road adjacent to the central station is supplied either by a direct current generator or from a set of rotary converters. The sub-stations are fed from the main alternators; the high-tension current of 5000 volts being converted to 600-volts direct current by a set of rotaries in each substation.

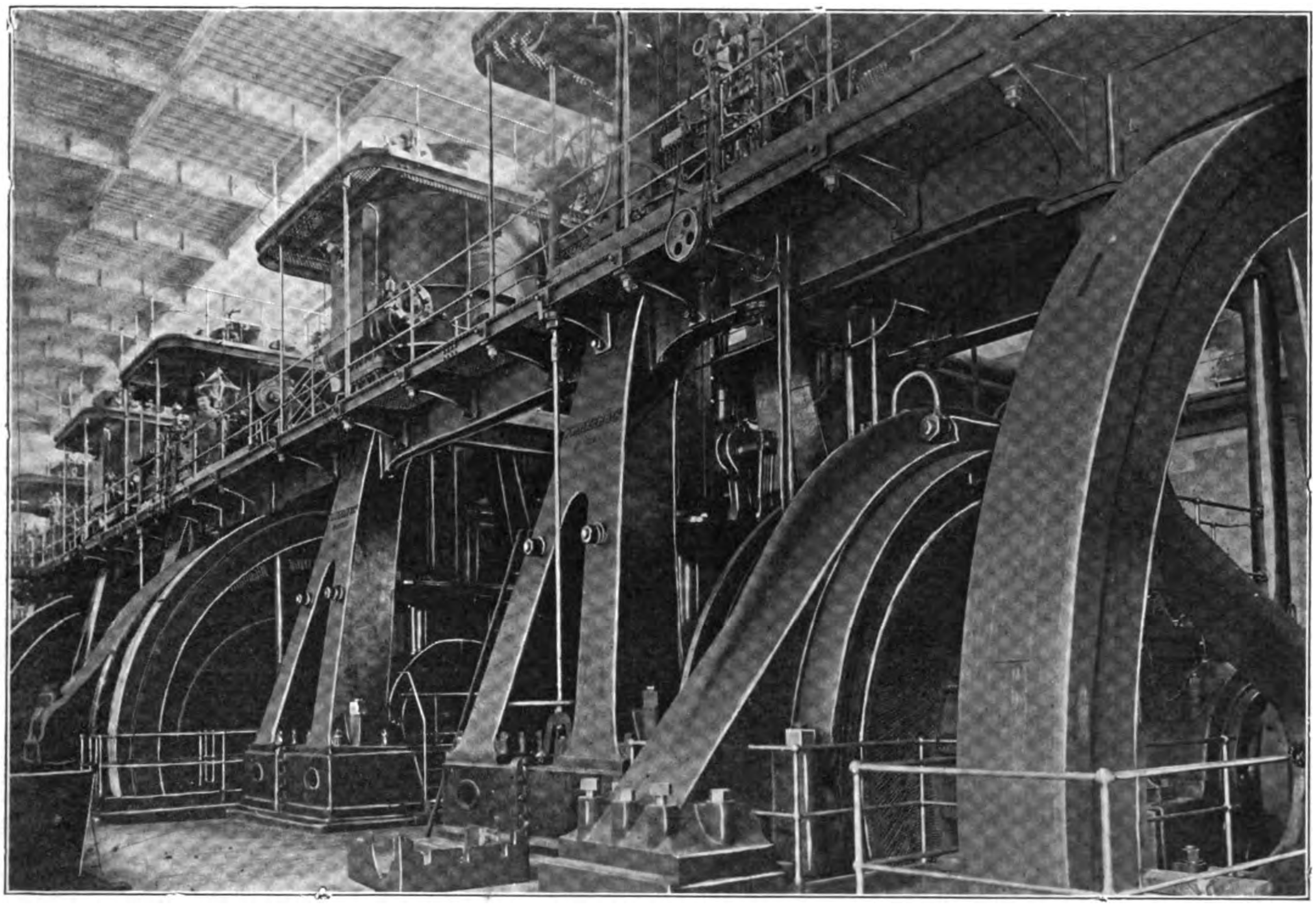

FIG. 1.—GENERAL VIEW OF MAIN GENERATING UNITS.

The plant is on the bank of the Seine at the Quai de Bercy, in the eastern part of the city, and the output is sufficient for the existing lines, but it is now being increased considerably in order to supply new branches of the road. The plant consists of a large office building fronting on the Seine, back of which is the generating station. At present the electrical equipment occupies the central building, with a boiler room on one side; but the dynamo room will shortly be extended back to the Rue de Bercy to accommodate several large generating sets. A second boiler room similar to the first will extend along the other side of the dynamo room and will supply the new equipment.

The main dynamo room at present contains four main generating sets of 1500 kilowatts each, comprising three alternators and one direct-current generator; also four rotary converter sets of 750 kilowatts, with their transformers. The exciting current is supplied by four direct-coupled units. Two booster sets work in connection with a large battery of accumulators operated in parallel on the direct-current bars. The boiler room contains five batteries of six boilers each, with a series of coal-bins having a capacity of 2500 tons. The water for the plant is taken from the Seine through two large conduits. Coal is brought into the station directly from barges on the river by a system of electrically operated conveyors.

A view in the great boiler house of the Metropolitan plant is given by Fig. 2, which shows the batteries of boilers and the system of overhead piping. On the right are the coal bins, from which the coal is fed to the boiler room floor in front of the grates. The additional boiler plant now being erected will occupy a room of about the same size on the other side of the main dynamo room. The boiler plant was constructed by Schneider & Company, of Creusot. These are of the semi-tubular pattern. Three large smokestacks are in use, two of which are placed between the batteries, with the third at the outer end. The supply pumps and feed-water heaters, with the filters, are also placed in the space available between the boiler batteries.

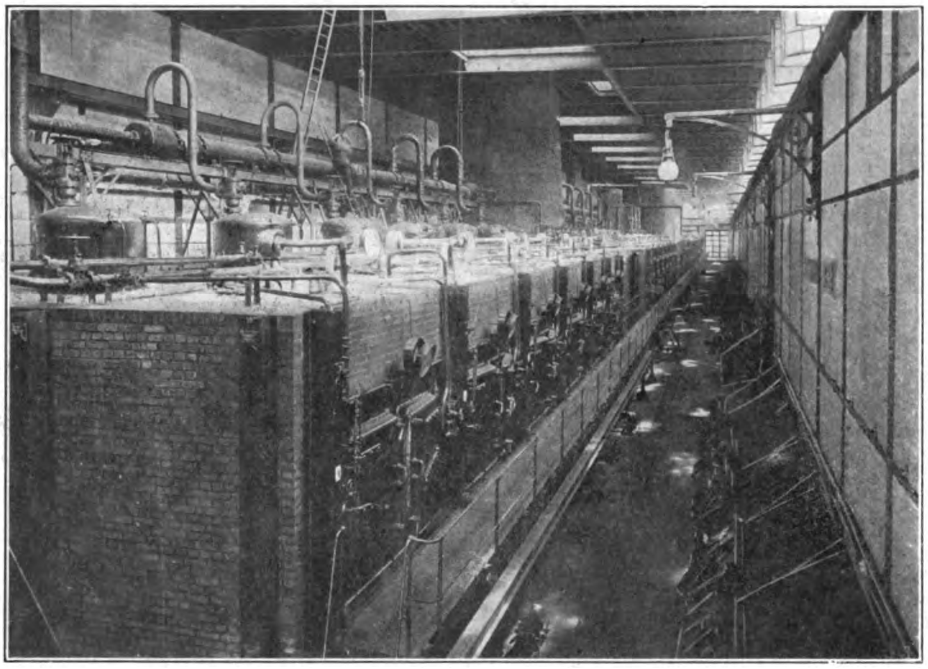

FIG. 2.—VIEW OF BOILER ROOM.

The boilers have a total heating surface of 2800 square feet. A bridge or platform which runs along the front allows the tubes to be cleaned easily. Here are also stationed the attendants who oversee the stoking of the furnaces. The feed-water for the boilers is taken from a reservoir by a set of small feed-pumps. The water passes first through a set of tubular feed-water heaters, which are heated by the steam coming from the exhaust of the pumps, then through the meters and finally to a set of large tanks from which it is sent to the boilers. A by-pass allows the water to pass directly from the tanks to the boilers in case it is necessary to remove or repair the feed-water heaters or the meters. The ash-collecting system has been installed on the most improved plan. Under each furnace is an ash-pit or conduit which runs to a long gallery extending underneath the boiler room. A series of ash-carts circulates in the gallery into which the cinders are fed from any one of the ash-pits by opening a trap. The ash-carts take the cinders along the track to a chamber in one end of the gallery, where they are dumped into the buckets of an upright conveyor which elevates them to the surface. The combination of ash-pits and coal-bins leaves the floor of the boiler room entirely free.

The extensive system of coal conveyors which is used in the Metropolitan station has been well planned, and the entire handling of the coal is carried out by mechanical devices which are practically automatic. Electric motors operate all the conveyors, so that the coal is unloaded from the boats at the wharf alongside the station and then automatically weighed and stored in the coal-bins alongside the boilers in the most efficient manner. A revolving electric crane lifts the coal from the barges and dumps it into a hopper whose mouth is flush with the wharf. The hopper feeds it into a horizontal underground conveyor which passes in a tunnel under the wharf. At the station the horizontal conveyor feeds the coal into a bucket elevator which takes it to the top floor. After being automatically weighed, the coal is taken to the bins by a third conveyor of the horizontal type.

The underground system which passes beneath the wharf is 320 feet long. It is made up of an endless metallic platform composed of a series of sheet-iron sections of channel form having a height equal to one-fourth the width. The platform thus constituted is mounted on an endless chain of the Burton type, which transmits the tractive effort from the electric motor. The sections are provided with a set of rollers which run upon an angle-iron rail attached to the sides of the tunnel. The gallery ends in an underground chamber, where the coal is poured from the conveyor by a chute into the buckets of the vertical conveyor. The latter is 80 feet high and takes the coal through a shaft to the top of the station building. Here is located the automatic weighing apparatus, and the coal is fed from the conveyor by a hopper into the scale, which weighs one ton at a time. An automatic device operates the opening and closing of the gates which feed the coal into the bin of the scale and empty it after weighing into the third conveyor. The latter is made up of a series of buckets and takes the coal in a horizontal direction over the bins. The buckets have a capacity of three cubic feet each, and are provided with rollers which run over a pair of side rails. An endless chain is attached to the buckets and is driven by an electric motor. The buckets are pivoted at the sides and are normally in an upright position throughout the whole conveyor. When in the underneath position the buckets run just over the ceiling of the large chamber which forms the coal-bins. The conveyor has a set of trip devices which can be set by the workman in charge so as to upset the buckets over any one of the openings of the coal-bins. This allows the latter to be fed automatically. The system will deliver nearly 70 tons of coal per hour, and its operation has never given any trouble. The work expended in transporting the coal over a total distance of 600 feet, including an elevation of 80 feet, is only 20 horse-power. As practically all the apparatus is motor-driven, the whole outfit requires the attention of but two men.

The main engines for the large direct-connected groups which occupy the greater part of the dynamo room were built by the Schneider Company, and are of the vertical compound condensing type. Fig. 1 shows the disposition of the direct-coupled sets which occupy a long file in the center of the station, leaving a passageway on either side. The engines have an indicated horse-power of 2600 and operate at 70 revolutions per minute. The diameter of the large cylinder is 72 inches, and that of the small cylinder 44 inches. The piston stroke is 60 inches. The diameter of the main shaft in the bearings is 20 and 22 inches. A heavy fly-wheel is used with these engines, measuring 25 feet in diameter and weighing about 70 tons.

The fly-wheel and dynamo of each group are mounted below the cylinders and the shaft is supported in a bearing at each end which is fixed in vertical columns, with a third bearing between the fly-wheel and the dynamo. The disposition of the direct-current group and the three alternate sets is quite similar. Each group is supported on a foundation 36 feet long by 34 feet wide and 40 feet deep, which is laid below the level of the main floor. On account of the proximity of the plant to the Seine, the work of sinking the foundation had to be carried out by means of compressed-air caissons.

The engines use the Corliss system of valve distribution, and as great regularity is required in running so as to allow of coupling the different alternator groups in parallel under the existing conditions of varying load and sudden shocks, the regulating devices have been made the object of special study. Each engine has two methods of regulation. One of these is a governor of the usual type which acts upon the trip mechanism of the small cylinder. The action of the second regulator is carried out by means of an auxiliary motor which exercises a special regulation on the steam inlet, so as to avoid all racing of the engine which might occur when the load is suddenly thrown off. The motors operate a series of gate-valves which are placed in the inlet of each of the cylinders.

The alternators are of the Ganz type, and have been built by Schneider & Company at the Creusot establishment. These machines have a normal capacity of 1500 kilowatts, but they can easily carry a temporary load of 2000 kilowatts without undue heating. They operate at 5000 volts and 25 cycles, and run at a speed of 70 revolutions per minute. These alternators are of the revolving field type; the field casting, which serves at the same time as a fly-wheel, is built of two simicircular parts which are bolted together. The exterior rim is connected to the hub by eight double arms. Upon the periphery of the casting is mounted a set of 42 field-poles of cast-steel.

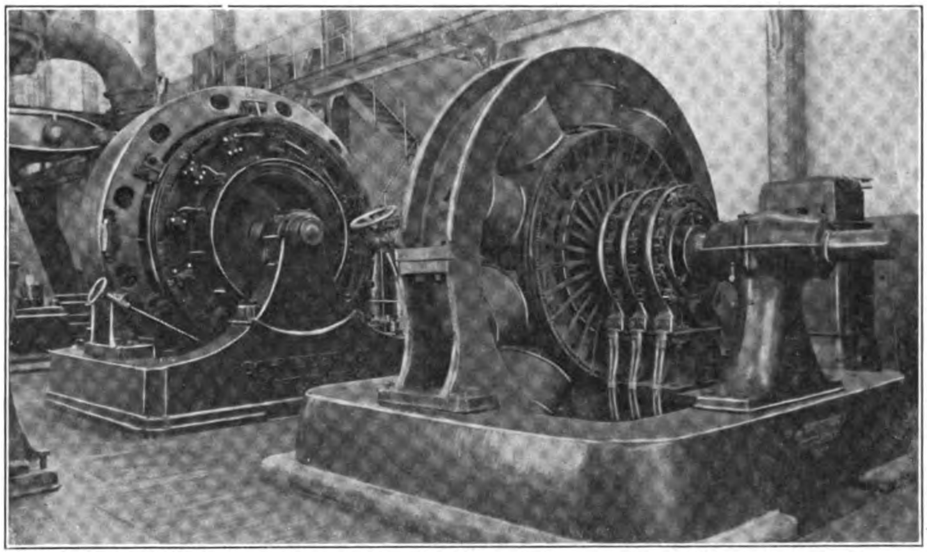

FIG. 3.—ROTARY-CONVERTER SETS.

Special care has been taken to give the field coils a solid construction, and they are forced in place at a strip winding which is forced to place at a high pressure. In this way a tangential speed of 80 feet per second can be reached in the revolving part without danger of the coils becoming loose. The field is connected with the 42 coils in series. The exciting current is brought from a two-ring collector mounted on the shaft which receives the ends of the field winding. An exciting current of 250 amperes and 100 volts is used.

The fixed armature casting which forms the outer body of the machine is built in two half-rings which are bolted together. Around the inner periphey are inserted the laminated sections which from the armature ring. This part of the machine is well ventilated by a series of air-spaces in the laminated portion which correspond to a set of holes in the outer casting. The laminated ring contains 378 slots for the winding; 18 of these are left empty in order to facilitate the removal of the winding. Copper cables are laid in the slots and the three circuits formed are connected on the star system. The active length of armature iron is 18 inches and the field bore is about 20 feet, with an air-gap of 0.3 inch. The revolving part weighs about 29 tons, while the total weight of the machine is 90 tons.

In the foreground of Fig. 1 will be observed the large direct-current generator, which has about the same external appearance as the alternators. It delivers a current of 3000 to 3500 amperes at 600 volts. This machine has been designed so that it is not necessary to shift the brushes when running under different loads, as the lead does not vary more than 5 per cent no matter what the load is. The outer field frame is built in four parts. The frame carries a series of 20 pole-pieces around the inner periphey which are cast with the field. The armature which is mounted on the engine shaft is of the slotted drum pattern. The laminated portion, which is built up on a cast-iron drum, is formed of 0.014-inch sheet iron. In the slots is laid a winding of 2160 copper bars having a section of 750 by 850 millimeters, or 63.75 square centimeters. The armature carries 540 slots, measuring 10.2 millimeters deep and 11.3 wide. The effective length of armature iron is 24 inches. On the side next the fly-wheel may be distinguished the large commutator, which is 25 inches in diameter and 16 inches long. It is built up of 1080 copper strips, insulated by mica. The commutator carries 240 brushes, which are mounted in 20 brush-holders. The total weight of the revolving part of the generator is 38.5 tons, while the whole machine weighs about 55 tons.

The exciting current for the alternators is supplied by four rotary groups, which are situated between two of the main alternators, together with the booster sets. Each of the four exciter groups is formed of two direct-current machines of the Schuckert pattern which are coupled together on the same shaft. The first machine receives direct current at 600 volts and acts as a motor to drive the second dynamo. The latter machine furnishes direct current at 130 volts for exciting the fields of the alternators. These four groups are of similar construction and operate at 650 revolutions per minute. Each exciter has a capacity of 70 kilowatts, which is sufficient to supply two of the alternators.

The station also contains two direct-current groups of 200 kilowatts each which act as boosters and are operated in connection with the large battery of accumulators in the station. These groups are stationed next the exciter sets, and consist of a direct-current motor of the Schneider pattern, direct-coupled to a specially-designed generator which has a capacity of 2000 to 3000 amperes at an e.m.f of from 50 to 100 volts. Both motor and generator are of the 8-pole type. These groups operate at a speed of 325 revolutions per minute. The armature of the generator is provided with two separate windings, which are connected in parallel and run to a commutator of large size. The fields of the motors are connected in shunt, while the fields of the generators are excited in series. These latter machines are placed in series between the direct-current bars and the storage batteries, and serve to regulate the tension of the battery charge and discharge. During the period when the main circuit is but slightly loaded, the main generators are used to charge the storage battery, and in this case the boosters, which are in series in the circuit, serve to give the added voltage which is needed to charge the batteries properly. During the times of heavy load on the direct-current generators the battery is used to help out the machines and is worked in parallel on the circuit, serving as usual to keep the voltage constant and take up the overloads. The boosters give an additional regulation of the voltage so as to secure the proper workings of the machines and batteries in parallel.

The storage battery which is used for this purpose is of large capacity, and is placed in special rooms in the basement of the office building. It is made up of 250 cells of the Tudor pattern. The battery has a capacity of 1560 ampere-hours on a one-hour discharge, but can easily stand a temporary load of 3000 amperes. The terminals of the battery circuit are connected to the direct-current bus-bars of the main switchboard. By using the battery the voltage of the direct-current circuit is kept within 5 per cent of the normal during the varying loads.

Besides the main generating groups and other auxiliary machines, the station contains four sets of transformers and rotary converters. These are designed so as to supply direct current by means of the main alternators of the station and act as a reserve which may be used instead of the large direct-current generator to supply the traction lines which are fed directly from the station when the load does not exceed 1500 kilowatts. The transformers and rotary converters are installed on the same lines as the apparatus in the sub-stations throughout the city. Fig. 3 shows the right-hand half of this plant, which is placed in the forward end of the main dynamo room, and consists of four groups of 750 kilowatts capacity each. Each of the four groups is made up of three static transformers of the 3-phase type, which lower the voltage of the main alternators from 5000 to 430 volts, together with a rotary converter which receives the alternating current at the latter voltage and converts it to 600 volts direct current.

The three-phase transformers are placed in two banks of six transformers each, one on each side of the dynamo room, with the four rotary groups between them. The transformers of one set are of the Ganz pattern, constructed by Schneider & Company, while the second set has been built by the Société des Etablissements, Postel-Vinay, of Paris. The primaries of the Ganz transformers are connected on the triangular or mesh system, while the secondaries are independent. Each of the transformers has a normal capacity of 300 kilowatts, and weighs about six tons, including the case. They are of the upright pattern and are formed of two columns of laminated iron which support the concentric primary and secondary coils. At the base they are fitted into a cast iron supporting piece. A yoke connects the columns across the top, and it is removable so as permit the removal of the coils.

In order to provide for a good ventilation, an air-space is left between the primary and secondary coils. The transformers are air cooled, being placed over an opening in the floor which connects with a horizontal air-conduit running under the bank of transformers. At the end of the conduit is a motor-driven fan. The second bank of transformers has the same general construction.

The rotary converters, whose general appearance will be observed in Fig. 3, are disposed in two pairs. The two machines in front are of the Postel-Vinay make, while the rear pair have been built by the Schneider Company. The fields of the Ganz machines are formed of a circular cast-steel frame made in two pieces bolted together. On the inner periphey it carries 12 cast-steel pole-pieces. The armature is of the drum pattern, with a winding of copper bars of large section lodged in a series of slots in the laminated ring. On the alternating current side the armature is divided into six sections, which are connected to six collector rings. Carbon brushes bearing upon the rings bring the alternating current from the transformers.

On the direct-current side of the armature the commuator of large diameter carries 12 sets of brushes. These rotary machines can be worked as high as 1000 kilowatts for a considerable time without overheating. Their speed is 250 revolutions per minute. The field bore of these machines is 81 inches and the air-gap 0.5 inch. The commuator measures nearly 50 inches in diameter, and the working surface is 12 inches wide. The total weight of these machines is about 29 tons. When working at 1000 kilowatts the rise of temperature above air is not more than 25° C. for the armature and 11° for the field. The maximum efficiency is about 95 per cent when working on full load. The rotary converters of the Postel-Vinay pattern are constructed on the same line. The alternating current is brought from the transformers by a double cable to three collector rings, which will be noticed in the foreground, as well as the special type of brush-holder which has been designed for these machines, carrying six copper brushes.

The apparatus contained in the station makes it necessary to have an extensive switchboard in order to carry out all the different operations, besides providing for the alternating and direct-current feeders. The switchboard, which contains 31 white marble panels, is located in a gallery 16 feet above the main floor, and is reached by an iron staircase. It is laid out so as to provide for the new portion of the Metropolitan plant. When the new machines have been erected there will be seven panels for the three-phase alternators and one panel for the main direct-current generator. The exciter sets require four panels, and the booster sets each one panel, with one for the storage batteries. The rotary converter groups use four panels. The high-tension feeders which lead to the sub-stations in the city require eight panels, and the station lighting and power circuits three panels. The latter are placed below the main switchboard.

The Bercy plant has been in operation for some time past, and is called upon to provide for the constantly increasing traffic on the Metropolitan lines. The successful running of the station is largely due to the efficient supervision which is given by its director, M. A. Faiveley, a prominent electrical engineer of Paris.

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AUTOMATIC DAMPER REGULATORS.

BY R. T. STROHM.

To maintain a uniform working pressure in a steam boiler, which is a point for which efficient firemen strive, it is necessary to maintain a fixed ratio between the heat supplied by combustion and that taken away by the steam drawn from the boiler. The expedient of supplying more or less fuel to the furnace, as the case demands, is not a good one, when used by itself, since it is wasteful of fuel. For it gives a maximum supply of air when the fire is thinnest and a minimum when the fire is thickest, inas-

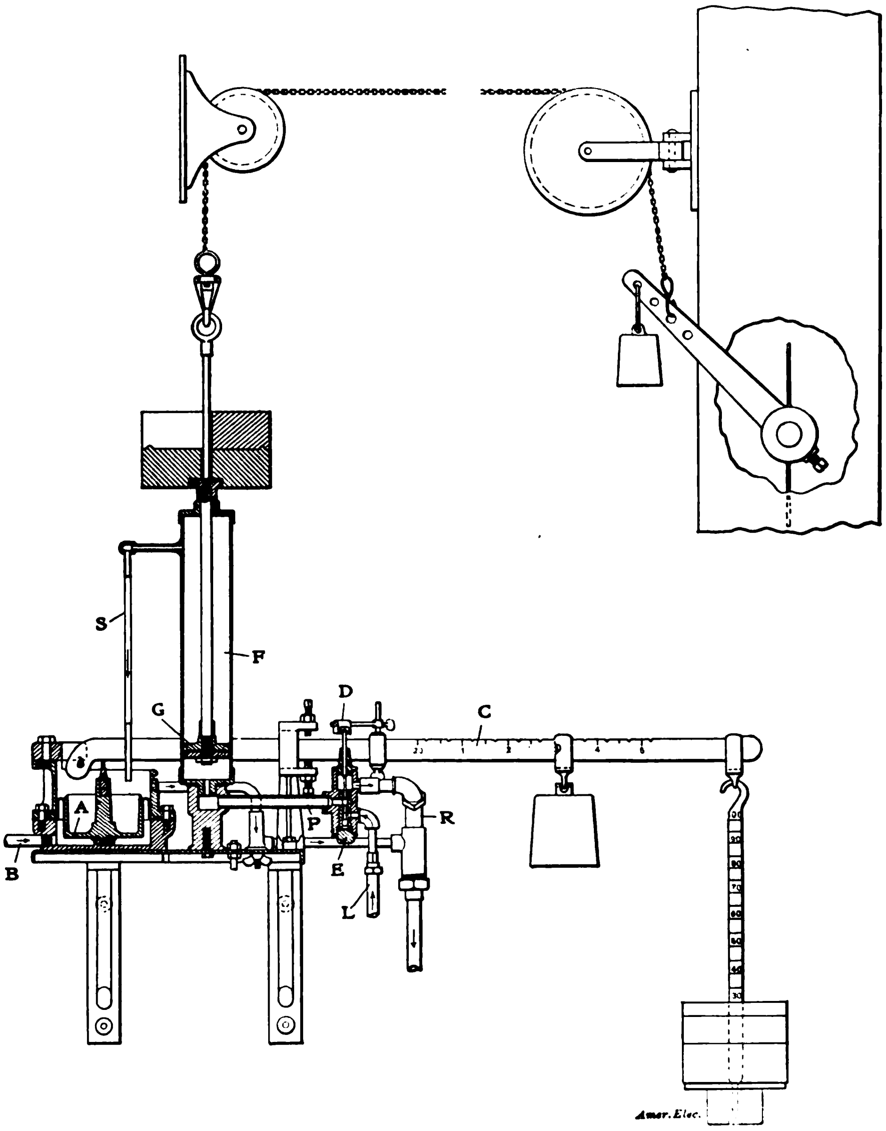


FIG. 2.

much as the resistance offered to the passage of air is less through a thin fire than through a heavy one. The reverse should be observed wherever possible. The thick fire should have the greater air supply and the thin one the smaller.

In order to secure the highest economy of combustion in the furnace, it is necessary to regulate the air supply in accordance with the rate of combustion. In plants where the demand for steam is uniform, it is not a difficult matter for the fireman to maintain a fairly constant steam pressure, since a regular rate of firing and little or no manipulation of the damper are required. But if the demand for steam is variable, so that there is a constant tendency toward fluctuation of pressure, then it will tax the energies and resources of the best fireman to keep the pointer of the steam gauge even approximately steady at the desired working pressure. For, with his numerous duties, it will be impossible for him to adjust the damper just the right amount, and at the right time, to counteract each fluctuation that the gauge may indicate. He could not do so even by devoting his undivided attention and entire time to the task.

The automatic damper regulator obviates the necessity for any such close watchfulness on the part of the fireman. It is automatic in its action, as its name implies, always sensitive to changes in the pressure, and when in proper working order it responds quickly and efficiently to all fluctuations. In doing this, it proves of value not only as a time and labor saver, but also as an economic appliance, since it gives better combustion at the varying rates employed, thereby saving fuel.

The simplest, but also the least efficient type of damper regulator, is that shown in Fig. 1. It consists of a circular diaphragm, *A*, securely fastened between the flanges of two saucer-shaped pieces forming a chamber. Beneath the diaphragm steam at boiler pressure is admitted by the pipe *B*, the upper surface of the diaphragm being subject only to atmospheric pressure. To the diaphragm is attached the rod *C*, having a pin joint connection at *D* with the lever *H*, which is fulcrumed at *F* and provided with an adjustable weight *G* at one end, the other being connected at *E* to the chain *K* controlling the damper movement. As the pressure in the boiler rises, the diaphragm *A* is bent upward at its center, carrying with it the pin *C*, which lifts the weight *G* and lowers the end *E* of the lever, this motion being transmitted by the chain *K* to the damper, closing the latter. When the pressure falls, the weight *G* forces the diaphragm downward, and a counterweight on the arm of the damper opens the latter again. This was the first crude step in automatic damper regulation, and like most first attempts, it was capable of much improvement.

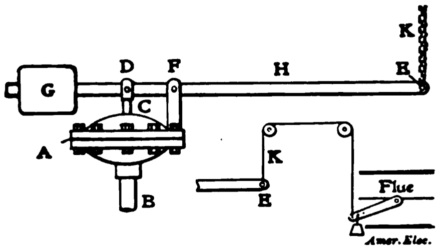


FIG. 1.

In the first place, it was necessary for the pressure to rise sufficiently to overcome the resistance of the diaphragm, the pressure due to the weight *G*, and that due to the weight on the damper arm, before the damper would begin to move. And once started, it would continue to move until the damper had completely closed the flue. In other words, the damper was either fully open or fully closed. This was not very desirable regulation, and as a consequence the successful damper regulator of to-day is a great deal superior to the one just described in all ways, excepting that of simplicity of construction.

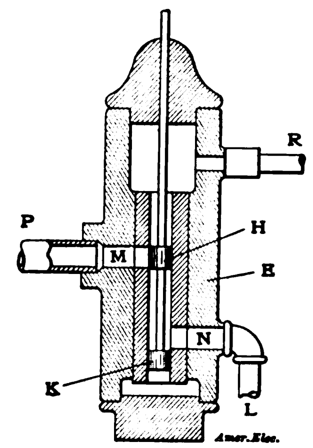


FIG. 3.

Among the many commercially successful regulators of the present day, that shown in Fig. 2 on the opposite page is an excellent representative of the class using a diaphragm and weighted lever to operate a small water valve which controls the motion of the plunger to which the damper chain is connected. Steam at boiler pressure is admitted to the chamber beneath the diaphragm *A* through the pipe *B*. Any motion of the diaphragm is at once transmitted to the lever *C*, the free end of which, owing to the method of pivoting, moves through a considerably greater distance than the diaphragm. This lever is weighted and graduated, so that the regulator may be set to act at any desired pressure by simply adjusting the weights. Rigidly attached to the lever *C* by an adjustable arm *D* is the water valve *E*, of which a larger view is shown in Fig. 3. This valve permits the flow of water, at the pressure in the main, to or from the hydraulic cylinder *F*, in which the piston *G* slides and with which the damper is connected.

When the steam pressure gets slightly above the desired working pressure, the diaphragm rises, since the weights have been so adjusted as to make the lever sensitive to very small changes of pressure. The lever *C* is thus lifted, and in turn lifts the stem of the water valve *E*. To this stem are attached the small pistons *H* and *K*, Fig. 3. The upward movement of the stem causes the piston *H* to open slightly the port *M*, and water under street pressure flows from pipe *L* through the ports *N* and *M* into the pipe *P*, and thence to the cylinder *F*, raising the piston *G* and shutting the damper. If the rise in pressure is considerable, the piston *H* uncovers port *M* fully, due to the greater rise. But at the same time the piston *K* rises an equal amount, and partly covers the port *N*, thus throttling the incoming water, and preventing the damper from being completely closed at one stroke. When the pressure falls, the lever *C* descends, forcing pistons *H* and *K* downward. The piston *H* thus uncovers the port *M* at its upper edge, and the weights on plunger *G* force it down, the water in the cylinder escaping through the port *M* to the overflow at *R*. The valve *E* is provided with a bushing which is quickly and cheaply renewable, so that the pistons *H* and *K* may always be in good condition. Any leakage of water past the plunger *G* flows out through the drain pipe *S* into the diaphragm cup and thence into the overflow by suitable pipes.

The advantages of this regulator over that shown in Fig. 1 are easily recognized. It is far more sensitive, since the diaphragm and lever are used simply to move a small valve having little friction, whereas, in the former case, the damper was controlled by the main lever. The use of water under pressure makes it possible to move heavier dampers than could be operated by the direct-acting lever.

The use of the diaphragm and weighted lever is a feature of many regulators, but the methods employed to secure a proper motion of the damper piston are varied. In Fig. 4 is shown a very ingenious mechanism. Boiler pressure is allowed to act on the under side of the diaphragm *A* through the pipe *B* and the connecting port, thus raising the lever *C*, which causes valve rod *D* to rise also, carrying with it the rod *E*, to which is attached the water valve. As the valve ascends, it opens the port *F*, allowing water under pressure to enter from *G*, and forces the piston *H* downward. This piston being attached to the wheel *J*, by a chain, causes the latter to turn. On the same shaft with *J*, but outside the casing, is another chain wheel *K*, on which the damper chain is wound. When the pressure falls, the weight on the damper lever returns the parts to their original position. The port *F* is then put

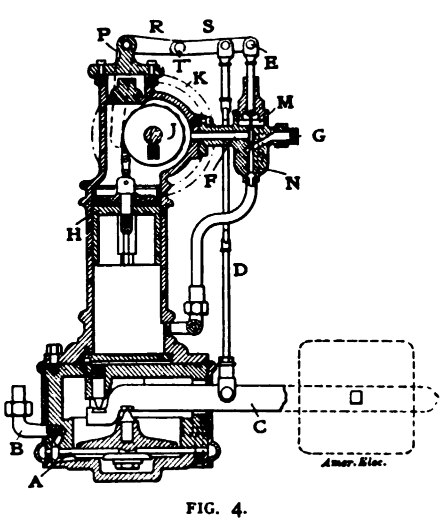


FIG. 4.

in communication with the chamber *M*, allowing the water above the piston to escape to the drip by way of the port *N*, shown dotted.

The mechanism employed to give the damper a partial stroke, so as to prevent its going completely shut at one movement, is extremely interesting. A skeleton view of this mechanism is shown in Fig. 5. A cam is attached to the shaft carrying the wheels *J* and *K*. This cam turns with the shaft, so that when the piston *H* descends and the wheel *J* revolves, it forces the end *P* of the bell-crank lever to the left, causing the other end *R* and the joint *T* to move downward. The arm *S* being jointed to the rods *D* and *E*, swings on the end of the rod *D* as a fulcrum and further raises the rod *E*, which shuts off the water and brings the damper to a standstill. This action is repeated, as the pressure rises, so that the closing of the damper is a succession of short movements, and not a continuous movement.

Still another type of hydraulic regulator is illustrated in Fig. 6. This one, however, dispenses with the diaphragm common to the foregoing regulators. The steam at boiler pressure acts on the upper side of a small piston, *A*. When the pressure rises beyond the desired limit, this piston descends, depressing the short end of the lever *B* as well as the water valve *C*. The upward movement of the longer end of the lever *B* lifts the slotted weight *D* by the chain, so that it no longer rests on the lower lever *N*. At the same time the valve *C* admits water from the inlet *H* to the water cylinder *K* through the port *J*, forcing the piston *M* downward and raising the free end of the lever *N*, to which is attached the chain leading to the damper. However, as the lever *N* rises, it picks up the weight *D*, which checks its motion somewhat, and the damper steadily closes. But, the lever *B* being thus relieved of a portion of its weight, is depressed still further by the steam pressure on *A*, and the valve *C* is completely closed. When the pressure falls to the normal point, the parts return to their former positions, the valve *C* opening the port *J* and permitting the water to be discharged through the overflow *P*. The transfer of the weight *D* from the upper to the lower lever gives the damper an intermittent, rather than a continuous motion.

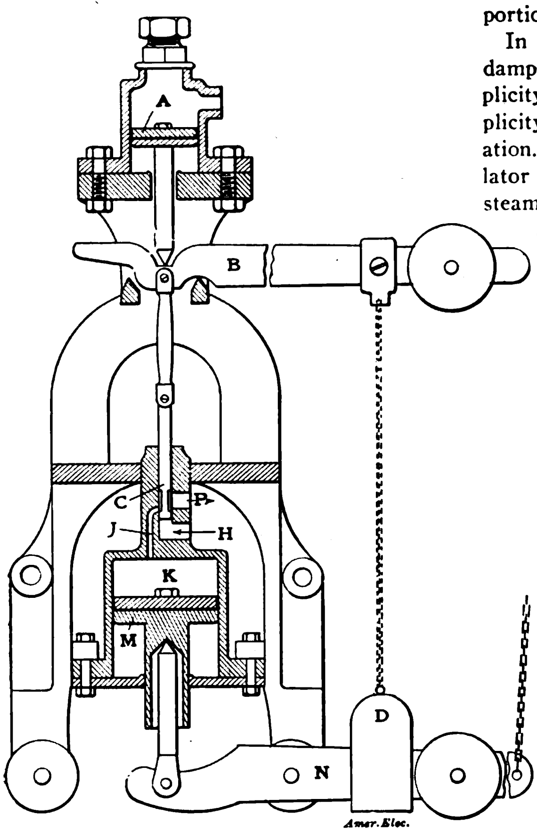


FIG. 6.

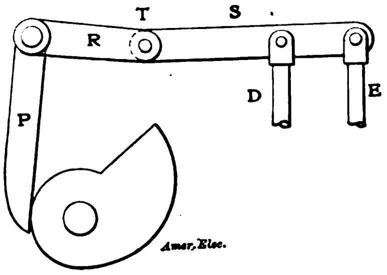


FIG. 5.

In the types thus far mentioned, the principle has been identical. That is, a piston is moved by hydraulic pressure, its motion being governed by a water valve the position of which is determined by the boiler pressure. The only marked differences in the foregoing devices have been the means of securing a movement of the damper proportional to the change in pressure.

In Fig. 7 is shown a mercurial column damper regulator, the constructional simplicity of which is parallelled by the simplicity of the principle involved in its operation. The sketch shows this type of regulator as designed for boilers carrying high steam pressures. As can be seen, it consists of two mercury columns precisely alike in construction, and joined end to end. The pipe *A* transmits the boiler pressure to a chamber *B*, in which it acts upon the surface of the mercury, forcing it up into the arm *C* and chamber *D*, partly filling the latter. The upper end of the chamber *D* and the whole of the pipe *E* are filled with water, which transmits the pressure to the second mercury chamber and column. This second column has at its upper end an open vessel, *F*, in which floats a cast-iron cylinder, *G*, to which is attached the rod by which the damper is moved. Thus, the boiler pressure plus the pressure due to the water columns in the pipes *A* and *E* just balance the sum of the pressures due to the two mercury columns. When the boiler pressure rises, the condensation in the pipe *A* transmits the pressure to the surface of the mercury in the chamber *B*, depressing it and causing the mercury column *C* to rise. The transmission of pressure continues through the second column, and the level of the mercury in the vessel *F* rises. The specific gravities of mercury and of iron being very different, the iron has been floating in the vessel *F*. As the mercury rises, the tendency is to float *G* as before, but at a higher level, and this movement of the cast-iron cylinder shifts the damper further toward its closed position.

A column of mercury 2 inches in height and one square inch in cross-section weighs approximately one pound. Hence, for every variation of one pound pressure in the boiler, the mercury level in the vessel *F* is changed 2 inches. The connection with the damper is made by a short lever, so that this amount of variation will suffice to swing the damper through its entire range. In other words, the limit of variation of pressure is one pound. Furthermore, the rise or fall of the weight *G* is directly proportional to the variation in pressure in the boiler, and the movement of the damper is simultaneous with the change of pressure since there is no intervening mechanism as in the types previously described.

When the pressure carried in the boiler is ordinary, a single column is sufficient. That is, the pipes *A* and *C* and chambers *B* and *D* may be dispensed with, and the pipe *E* connected directly to the boiler. In the case of low-pressure boilers, such as are employed for steam heating, the cylinder *G* may be made hollow, and weighted at its upper end to give the necessary sensitiveness.

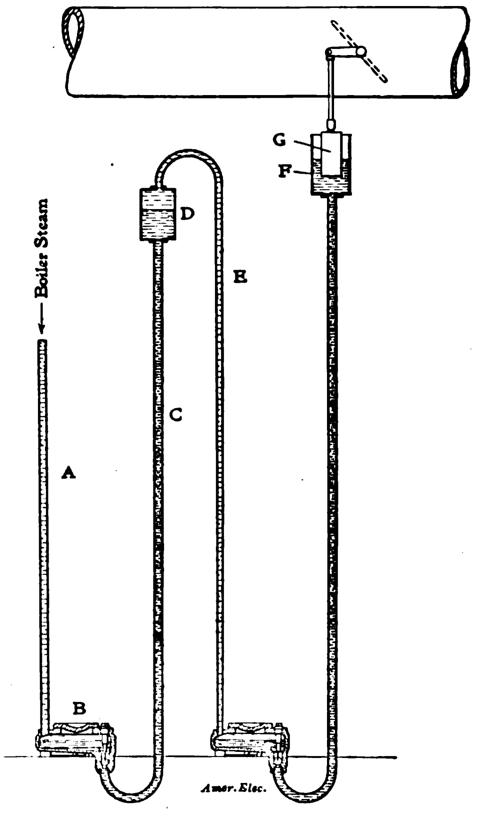


FIG. 7.

The construction of the mercury chamber *B* is shown clearly in Fig. 8. When under pressure, the mercury stands at about the level shown, thus presenting a large surface upon which the boiler pressure may act, and it requires only a slight depression of this surface to cause the level in the chamber *D* to rise considerably. At the outlet leading to the pipe *C* is a perforated plate, *H*, held to its seat by the spring *J*. Beneath this plate is a small casting consisting of four vanes recessed at their lower edges so as to form a cage for a small steel ball, *K*. The outlet is faced so as to form a seat at *M, M*, against which the ball may rest to form a tight joint. The purpose of this device is to prevent any loss of mercury due to undue increase in steam pressure, which might, if great enough, force the mercury out of the tubes. When the regulator is in proper working order, the steel ball floats in the mercury, leaving the outlet to the pipe *C* free and unobstructed. If, however, the pressure should rise abnormally and force all the mercury out of the chambet *B*, the ball *K* would then fall to its seat and close the outlet, preventing any further movement of the mercury column in the pipe *C*.

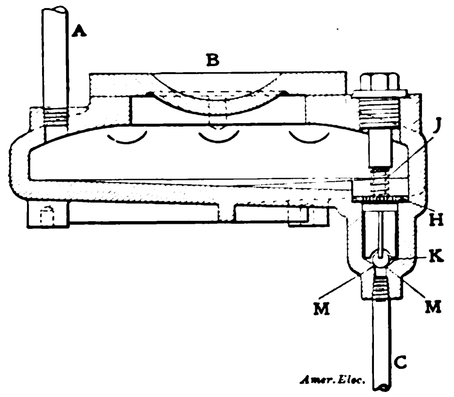


FIG. 8.

The degree of closeness with which the damper regulator will act is dependent largely upon the nature of the load to which the plant is subjected, and also, in a measure, upon the type of boiler. For example, if we consider a lighting station in which the load curve at its maximum is very nearly straight, the demand for steam will be uniform and the regulation will be an easy matter. Under these conditions, or in any other plant where the load is fairly constant, there should be no trouble in securing close regulation. But in a street railway power station things are radically different. The load on the engines is extremely variable, and this in its turn gives a varying demand for steam. Under such conditions it is impossible for the damper regulator to effect extremely close regulation, for the very reason that it requires time to accelerate the rate of combustion, or decrease it, sufficiently to affect the steam pressure. The steam engine governor acts very quickly and regulates very closely. But the damper regulator governs the steam pressure through the auxiliary process of combustion, which requires appreciable time.

The limits of variation of steam pressure as given in catalogues of damper regulator manufacturers are different, as might be expected. But the general statement is made than the variation should not exceed two pounds, between extremes. Nearly all makers state that their regulators are sensitive to changes of one pound in pressure, while some claim that a variation of a quarter of a pound, not detectable on the gauge, is sufficient to cause movement of the damper. The friction of the damper, and of the working parts of the regulator, would affect the sensitiveness to a great extent. Under very perfect conditions, it is probable that a damper could be regulated at a variation of one-fourth of a pound. But if the regulator will work continuously on a fairly steady load, allowing a variation, between extremes, of not more than two per cent, it may be considered as doing very satisfactory work. If the load is very erratic, a maximum variation less than five per cent of the working pressure may be considered as a creditable performance.

As mentioned previously, the boiler type also enters into the regulation question. The water tube boiler is a much more rapid steamer than the return tubular. The bulk of water contained in it is also considerably less than in a return tubular boiler of equal evaporative capacity. As a consequence, there is a greater liability to sudden fluctuation of pressure in the former than in the latter, and correspondingly greater difficulty in obtaining the same closeness of regulation.

In some cases, a single regulator is used to operate a large damper in the main flue or in the stack leading from a battery of boilers. In other places several individual dampers, in separate boiler flues, are connected to one shaft and operated by one regulator. Although under favorable circumstances this might do very well, it does not seem advisable to make the practice general. With a single regulator controlling the draft for a number of boilers, either by one main damper, or a number of connected individual dampers, it is essential that the fires be kept in a practically uniform condition, to avoid fuel waste. Unless this is done, one boiler will be given the greatest draft when it needs it least, perhaps, or the least draft when it requires the most. It would seem that by far the most desirable way would be to use a regulator for each boiler, thus assuring independent regulation for each unit.

The damper regulator, while being an automatic device, needs a certain amount of care and attention to keep it in proper working order. It has a certain number of moving parts which will wear, and which must be readjusted or replaced at intervals. In order to minimize the friction and the wear in regulators working by water pressure, it is usual to provide a lubricator on the pipe delivering the cold water to the motor cylinder. This lubricator consists of a small chamber in which is placed a piece of hard soap, which slowly dissolves, softening the water and lubricating the inner surfaces of the water cylinder. This chamber may also be used as a settling chamber, for the collection of sediment brought in by the water. To prevent the ingress of larger pieces of foreign matter, a strainer may be placed in the water supply pipe.

THE LAMME SINGLE-PHASE RAILWAY MOTOR.

The British patent on the Lamme single-phase railway motor has issued, and the specification contains a full description of the machine, together with a fairly complete exposition of the principles embodied in its construction. The following is a copy of the salient portions of the patent specification as printed by the London *Electrician*.

The invention has for its object the construction of an improved series-wound motor for use with single-phase alternating current. Hitherto alternating currents have been applied to operate series-wound motors, but considerable difficulties have arisen in the form of undue heating, excessive sparking of the brushes and low efficiency, together with poor regulation. The inventor states that he overcomes these defects, not by merely modifying the arrangement of parts of the ordinary series-wound motor, but by providing that certain definite proportions and relations shall subsist between such parts, together with various novel features in the construction of the motor.

Since the self-induction of the field-magnets and the counter e.m.f. set up by the armature are both dependent on the strength of field, a relation subsists between them which is proportional to the speed of rotation of the armature, the relative ampere-turns and the frequency. A higher speed, a low frequency and few turns on the field-magnets compared with those on the armature, will give a lower ratio of the field self-induction to the armature counter e.m.f. Both the field strength and the armature magnetic lines of force increase with the current supplied to the motor, and if saturation is not approached each of these will increase directly as the current, and, therefore, the torque which is produced by them jointly will increase as the square of the current, which would be a highly advantageous condition for electric traction work. Increase in strength of field, however, is accompanied by augmented self-induction which must be reckoned with. Inasmuch as the resultant of all the e.m.f.'s is equal to the applied e.m.f., increase in self-induction would result in a fall of speed, and if the self-induction of the motor becomes relatively high, the speed will fall very rapidly. Conversely, if the strength of the field be kept constant its self-induction will be constant, and, consequently, the armature speed will not fall unless its own induction be very high.

In the two cases above stated the first is that in which the strength of field is approximately proportional to the strength of the current, and in the second case the field magnetic strength is constant. As previously pointed out, the first case provides favorable conditions for electric traction, but it is limited by the fact that the maximum torque which can be developed may be insufficient for maximum requirements. In the second case the torque is not so limited, but on the other hand the general characteristics of the motor may not be suited to given conditions of working. It is therefore advantageous to proportion the motor so as to combine the two cases and thus secure conditions through a certain range of working in which the field strength is approximately proportional to the current, and have the motor capable of developing the required torque. It has been pointed out that the limitation in the torque developed when the field magnetic strength increases in proportion to the current, is due to the rapidly increasing self-induction of the field as the current is increased. It is desirable, therefore, to provide means for limiting the self-induction so that when a heavy torque is required, the self-induction shall permit a sufficient current to flow to produce the required torque. As the cross-induction of the armature through the poles acts with the self-induction of the field in limiting the flow of current, it is desirable that this should also be kept within proper limits.

The relations between the field self-induction and the armature counter e.m.f. may be expressed as follows: Self-induction of field = alternations × field turns in series × induction per pole × a constant. The counter e.m.f. of the armature = revolutions × the number of armature wires × induction per pole × a constant.

$$\frac{\textit{Field self-induction}}{\textit{Armature c.e.m.f.}} = \frac{\textit{Line alternations} \times \textit{field turns in series} \times \textit{induction per pole}}{\textit{Revolutions} \times \textit{armature wires} \times \textit{induction per pole}} \times \textit{constant};$$

since armature wires = 2 × poles × armature turns in series.

$$\frac{\textit{Field self-induction}}{\textit{Armature c.e.m.f.}} = \frac{\textit{Line alternations}}{\textit{Poles} \times \textit{revolutions}} \times \frac{\textit{field ampere-turns}}{\textit{armature ampere-turns}} \times \frac{\textit{constant}}{2}.$$

The constants are dependent upon the characteristics of the supply circuit and upon the units in which the different terms are expressed; their values are determined in any given case according to well-established laws, and the armature winding is assumed to be of the usual parallel type.

In a direct-current motor the armature alternations are equal to the product of the revolutions multiplied by the number of poles, and, since this relation may be assumed to obtain in a series alternating-current motor the foregoing formula may be further simplified by substituting the term "armature alternations" for the term "poles × revolutions." It has been pointed out that the self-induction of the motor should be relatively low as compared with the applied e.m.f., since the resultant of the self-induction of the motor and the counter e.m.f. is approximately equal to the applied e.m.f., and it follows that the self-induction should be low in proportion to the counter e.m.f. of the armature in normal working. The relation between the two is expressed in the foregoing formula.

In order that the ratio between the field self-induction and the counter e.m.f. of the armature may be low, it is clear that there must be a small number of line alternations, a large number of poles and a high speed, and a small number of ampere-turns and a relatively large number of armature ampere-turns. The ratio of field ampere-turns to armature ampere-turns has, generally, a minimum value which is fixed by the proper operation of the motor itself. If the field ampere-turns are too small as compared with the armature ampere-turns, the magnetic field will be distorted and good commutation will be difficult. The minimum ratio of field ampere-turns to armature ampere-turns is dependent upon many factors in the design, but in general it may be said that this ratio should be greater than 0.5, and may sometimes be as high as 0.75.

Therefore, when definite limits have been assigned to two of the ratios in the last equation—namely, the ratio of field self-induction to armature counter e.m.f., and the ratio of field ampere-turns to armature ampere-turns, then there is a definite relation between the alternations in the supply circuit, and the product of the number of poles of the motor and its rate of revolution. An average working value for the ratio of field ampere-turns to armature ampere-turns is approximately 0.625, and it has been found that the expression $\frac{\textit{constant}}{2}$ in the foregoing formula closely approximates the reciprocal of 0.625—*i. e.*, 1.6, so that the last two ratios of the formula cancel out, leaving only the ratios of field self-induction to armature counter e.m.f. and line alternations to armature alternations, for which definite limits are fixed, as hereinbefore pointed out. With a given number of revolutions, the number of poles must be directly proportional to the alternations in the supply circuit. Thus, for instance, if an eight-pole 700-revolution motor of a certain capacity is required for 2000 alternations per minute, 3000 alternations per minute will require a 12-pole motor at 700 r.p.m.

The forgoing considerations indicate the conditions required for securing a relatively low self-induction of the field of the motor. The field self-induction and the armature self-induction may both be limited by special construction of the pole-pieces. For instance, slots or holes may be cut in each of the field magnet poles near the pole-faces and parallel with the machine axis, the amount of iron left at the back of the slots being that which is required for the desired induction. The slots or holes may be closed, or nearly closed, at the pole faces, and usually this is preferred, as open slots increase the magnetizing power required in the field winding which, in turn, necessitates more field turns, and results in greater field self-induction. The cross-section of iron in the poles is preferably such that but little magnetizing power is absorbed in addition to that required for the air-gap until the current exceeds the normal rated amperes of the motor, when the teeth between the pole slots rapidly approach saturation. In order to secure this result, the parts in which the cross-section of the magnetic circuit is reduced should be of comparatively short length, but should, of course, be worked at a high induction. It is not necessary or desirable to subject the whole yoke to a high induction, as the desired results can be obtained by having a short length of small cross-section, whereas, if the whole yoke be subjected to a high induction, the losses due to reversals in the core will be objectionably large, and also the magnetic leakage into the surrounding frame and through the field windings will be objectionable.

The self-induction of the armature which results from a cross-induction through the poles, in which the magnetic lines enter at one edge or side of the pole and pass through the core to the opposite edge or side, is also reduced and limited by the arrangement of slots or holes described, and which would not be obtained in the same degree if the whole yoke were saturated, provided the field cores in the two cases required the same number of ampere-turns in the field for magnetizing them. The smaller the section of the pole teeth and the more highly they are saturated, the less will be the cross-induction with a given current in the armature. The magnetic reluctance of the field circuit is concentrated near the pole-face instead of being distributed through the whole yoke.

The total useful flux through the armature and field sets up no effective e.m.f. of self-induction in the armature windings, as it will add to the counter e.m.f. at one part and subtract at another part of such winding. But the e.m.f set up by the cross-induction does not neutralize itself in the same way, and thus becomes an e.m.f. of the same character as that set up in the field windings. The cross-flux from the armature may be further limited by the suitable interposition of a secondary circuit, if desired. For example, if a slot at the middle of the pole contains a conducting plate or closed coil, it will oppose the magnetic flow which would tend to cross the slot. If the ends of a conductor placed through the middle slot be connected with the outer frame of the machine at each end, or if the conductor be closed around the outside of the yoke, then the secondary circuit thus formed will oppose the flow of the cross-induction which tends to pass through the section of iron back of the slots.

The armature winding of the motor is of the closed coil type and is closed upon itself before being connected to the commutator, relatively high resistance leads being inserted between the winding and the respective commutator bars. As the magnetic field of the motor is alternating, any short-circuited turn through which the magnetic flux from a field-pole passes will have a secondary current set up to it. By the well-known laws of the transformer the ampere-turns in such short-circuited secondary will approximate the ampere-turns in the primary winding, which is, in this case, the field-magnet winding. Certain coils of the armature winding are short-circuited through the brushes when the adjacent commutator bars to which the ends of the coils are connected are bridged by the brushes, and when the latter are located in neutral positions or without lead, the short-circuited turns surround the paths of the magnetic flux and are, therefore, good secondary circuits in which relatively large secondary currents are set up by induction. This is the principal cause of the excessive sparking in series motors of ordinary construction, when it is attempted to operate them upon an alternating-current circuit. In order to obviate destructive sparking, the current in the short-circuited turns of the armature coil should be limited to an amount materially less than what would normally flow. By inserting a definite amount of resistance in each of the leads between the closed winding and the commutator bars, it is possible to so limit the secondary current due to the alternating field flux as to prevent injurious sparking. The working currents in the armature winding pass through these resistances only at the bars in contact with the brushes, because the armature winding is closed on itself inside or beyond the resistance leads.

With a given current in the motor, each armature coil which is short-circuited by a brush will tend to have the same e.m.f. set up in it irrespective of the e.m.f applied to the motor. Therefore, the resistance in the leads may be such that the short-circuited current developed will be limited in amount, and, generally speaking, with full-load current in the motor; the resistance should be such that the short-circuit current will not exceed, say, twice the value of the full-load current. The resistance in each short-circuit will include the resistance of the turn itself plus the resistance of two of the leads, plus also the resistance of the brush-holders and brushes.

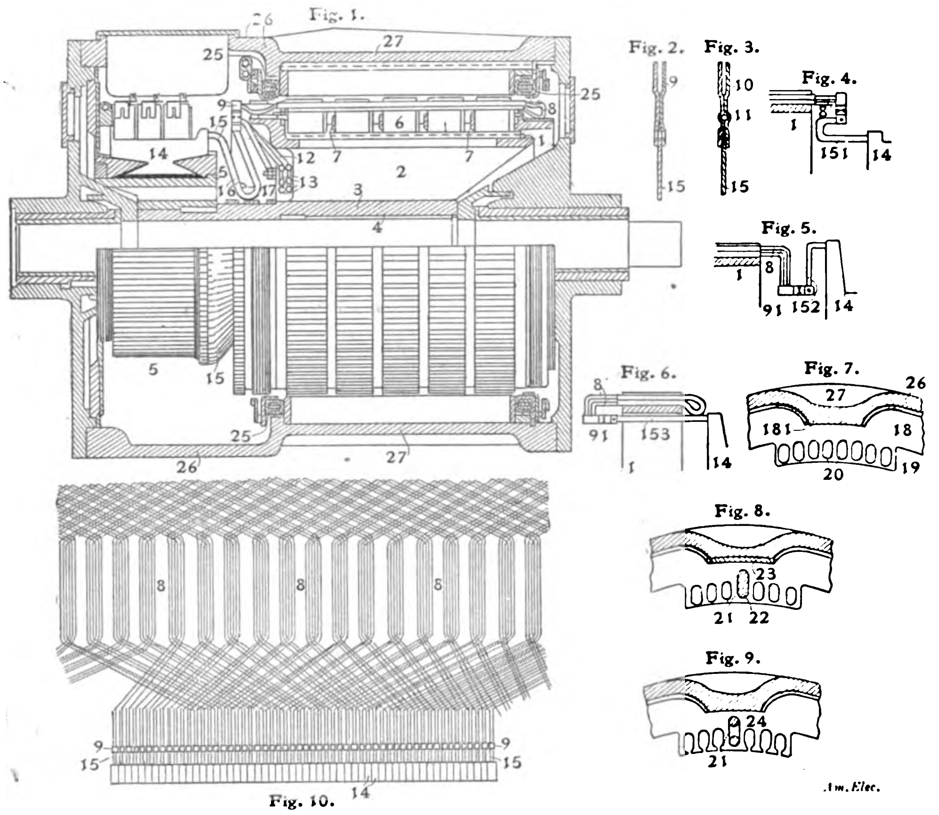
As will appear from what has already been stated, the conditions for suitably low self-induction and for a proper ratio of field ampere-turns to armature ampere-turns practically determine the number of poles the motor should have with a given rate of alternation and speed. This motor will require a relatively larger number of poles as compared with direct-current motors of corresponding size. Moreover, the conditions of good commutation are that the armature circuits of the motor be connected in parallel, and that the number of turns between consecutive armature bars be small. It follows, therefore, that the voltage of the motor is definitely limited, and it is found that the actual voltage is low relative to that for which direct-current motors may be wound—such, for example, as motors employed in ordinary electric traction. While this characteristic would be a serious limitation in connection with the distribution of energy for direct-current traction motors, it is of minor consequence in connection with alternating-current motors, since transformers may be interposed between the supply circuit and the motors, and these may be designed to receive practically any voltage from the line and to deliver any desired voltage to the motors. In service, a motor may require either a constant voltage or a variable voltage. For variable speed work the variable voltage is usually desired. A variable voltage may be obtained by the introduction of resistance or self-induction into the circuit or, preferably, by means of a transformer in which the rate of transformation is suitably changed.

The several elements which are involved are the motor, the controller, the supply circuit and the transformer. The motor, as has been pointed out, has inherent limitations as to the voltage for which it can be wound, which are independent of the transformers, the controller and the voltage of the supply circuit. The current and the voltage which can be more advantageously handled by the controller may be entirely different from those of the motor. For example, it may be advantageous to design the controller for one-third of the current and three times the voltage which are required by the motor. The line voltage may, in turn, be entirely too high to be introduced directly into the controller or the motor. It follows, therefore, that the voltage of the supply circuits and their respective currents, which may be most advantageously utilized, may be widely different. It is possible, however, by means of one or more transformers, to operate a motor adapted to any voltage by a controller adapted to any voltage from a supply circuit of any voltage. A convenient method of control consists in connecting a main transformer across the supply circuit, its secondary being included with the motor circuit, but having included in series the secondary of a series transformer, the primary of which derives current either directly or indirectly from the main circuit, and is capable of adding to or subtracting from the e.m.f. developed in the secondary of the main transformer.

This invention is applicable in cases where frequent starting is required, as, for instance, in electric traction systems. It is now the common practice in operating electric cars to have two or more electric motors upon each car, and for the purpose of securing varying speeds means are usually employed for connecting the motors either in series or in parallel, and for introducing more or less ohmic resistance into the circuits of the motors. With single-phase motors constructed according to this invention, it is possible to dispense with practically all ohmic resistances for regulating purposes, and it is not necessary to connect the motors successively in series and in parallel for the purposes of regulation, but the motors may be permanently connected either in parallel or in series and all the benefits of the usual series-parallel control as employed with direct-current motors may be obtained by varying the e.m.f. applied to the alternating-current motors. Control by means of variable ratio of transformation in the transformer provides a very much higher degree of economy in starting and at low speeds than is obtained in the usual method of operating direct-current motors where the voltage is reduced by means of rheostats, either with or without the series parallel method of control. The voltage delivered by the transformers is that required by the motor, so that there are practically no losses except those inherent in the transformers and motors, both of which are capable of being so designed as to have high efficiency. With this system, full-load torque or several times full-load torque at starting may be developed with a very small amount of energy from the supply circuit.

In the accompanying drawings, Fig. 1 is a view, partially in side elevation and partially in longitudinal section, of a motor constructed in accordance with this invention. Figs. 2 and 3 are detail sectional views of two of the combined resistance leads and connectors between the armature conductors and the commutator segments. Figs. 4, 5 and 6 are detail views illustrating modified arrangements of resistance leads for connecting the armature conductors with the commutator segments. Figs. 7, 8 and 9 are detail views of different forms of field-magnet core construction. Fig. 10 is a diagrammatic development of a portion of the armature winding and connections between the same and the commutator segments. As here shown, the armature 1 comprises a skeleton open-work frame or spider 2, the hub 3 of which is in the form of a sleeve mounted upon and suitably keyed to a shaft 4, this sleeve being extended at one end to receive a commutator cylinder, 5, which is also suitably keyed to it. The core 6 of the armature is built up in the usual manner of thin plates or laminæ, properly spaced apart at intervals by ventilating spaces 7 and provided with slots, which, in the present case, are 72 in number, in which are mounted the insulated conductors 8 constituting the coils of the armature winding. These coils or conductors, as shown, are of strap copper, the turns of which are located side by side in the slots, forming three separate coils, which span the core from the first to the ninth slot, and so on around the core. The coils are properly joined together at one end of the armature by means of suitable connectors, 9 and 10, so as to form a closed parallel winding. The connectors 10 are provided with sockets 11, in which are fastened the outer ends of suitable connecting wires or strips, 12, the inner ends of which are connected to balancing rings, 13, in a well-known manner.

For the purpose of reducing the secondary currents that are generated by the alternating magnetic field in the coils which are short-circuited at the brushes to substantially non-sparking limits, the connectors 9 and 10 are connected to the several commutator bars 14 by means of relatively high resistance leads 15, as previously described; there being in the present case 216 commutator bars and the same number of leads. These leads are strips of German silver. The commutator brushes are arranged in sets in the holders or arms, and, in the present instance, the arms or holders are eight in number. The brushes and arms may be of usual material and construction and connected in the usual manner to properly co-operate with the commutator and the supply circuit. As indicated in Fig. 1, the leads 15 are bent into substantially the form of U-shaped loops, the inner ends of which are held in place by means of a suitable winding, 16, an insulating band, 17, being interposed between the leads and the sleeve 3 of the armature spider. As illustrated in Fig. 4, the resistance leads 151 are shown as having a substantially U-shaped form, one arm of which extends beyond the other for connection to the commutator bar and the two arms of which are approximately parallel to the armature axis. In Fig. 5 the resistance leads 152 are shown as having each a main body position substantially perpendicular to the armature axis and an outer end which extends approximately at right angles to the body portion for connection to the commutator bar. In this case, the end of the armature conductors project inwardly, approximately parallel to the body portions of the leads, for connection to the connectors 91, which are also substantially at right angles to the body portions of the resistance leads. In Fig. 6 the resistance leads 153 are connected to the ends of the armature conductors, at the end opposite the commutator, and project through the spider to the commutator end, substantially parallel to the axis of the armature. Other forms and arrangements of resistance leads may, perhaps, be divided which will be adapted for the purpose. These shown are such as have been devised to most satisfactorily provide the necessary resistance and, at the same time, be economically and safely disposed in the available space in the motor.



DETAILS OF LAMME SINGLE-PHASE MOTOR.

As has already been pointed out the number of field magnet-poles of the motor must be directly proportional to the rate of current alternation in the supply circuit, and other conditions, which have been pointed out in detail, render it desirable, and, in fact, necessary, for successful operation that the rate of line alternations shall be low, and that the rate of armature alternations shall be relatively high. The motor here illustrated and described was designed for a frequency of 2000 line alternations per minute, and the motor which is adapted to this number of alternations and the other conditions has eight field-magnet poles. The field-magnet core 18 is in the form of a hollow cylinder, and is built up of thin plates or laminæ, the laminated construction being necessary by reason of the fact that the magnetic flux, due to the field-magnet winding, is alternating.

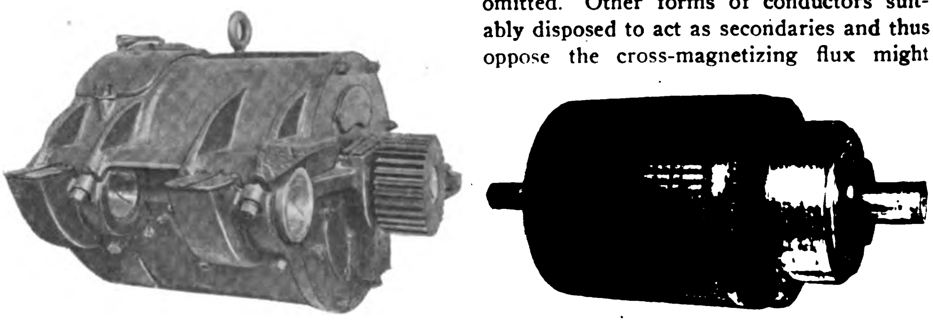


FIG. 11.—VIEW OF LAMME SINGLE-PHASE MOTOR AND ARMATURE.—FIG. 12.

The polar projections or pole-pieces 19 are provided with holes or perforations 20 extending through the same, transversely to the direction of armature rotation, and located in close proximity to the ends of the polar projections or pole-pieces, and the depth of the body portion of the core is reduced at the rear of each polar projection, as shown at 181, in Fig. 7, in order to aid in reducing the cross-magnetization and, consequently, the armature self-induction. The slots 20 are made comparatively shallow in order to keep the iron loss low and at the same time to ensure the desired saturation of the adjacent iron when the current materially exceeds the rated amperes of the motor. These slots may be entirely closed at the pole-faces, as indicated in Figs. 7 and 8, or they may have narrow openings, as shown in Fig. 9, but in every case where open slots are employed the openings should be small. As shown in Fig. 7 there are eight of the holes, 20.

In Fig. 8 are shown six holes, and at approximately the middle of the pole-piece is a hole, 21, which is of materially greater depth than the others. In this hole 21 is located a bar or plate, 22, of copper or other good conducting material, for the purpose of serving as a closed secondary circuit to reduce the armature self-induction due to the cross-magnetization. In Fig. 8 is shown a plate, 23, of copper or other good conducting material, which also acts as a secondary closed circuit to oppose any cross-magnetizing flux which tends to pass outside of the core 18 of the field-magnet. In Fig. 9 the construction is the same as that shown in Fig. 8, except that a single turn, 24, of wire constituting a closed coil is placed in the middle of slot 21, instead of the bar or plate 22, and the plate 23 is omitted. Other forms of conductors suitably disposed to act as secondaries and thus oppose the cross-magnetizing flux might be employed, if desired, those shown being set forth merely as examples that have been found well adapted for the purpose. The field magnet winding 25 is here shown as comprising eight coils of strap copper, bent edgewise and connected in series. In the present case the winding comprises 20 turns, one-half of the coils having three turns and the other half having two turns, and the coils of the two sets are alternately disposed around the core. A greater number of turns may be employed, if desired, provided they are so connected that the number of turns in series does not materially exceed that specified above.

The field magnet core and coils are mounted in a casing, 26, which is provided with extensions at its ends to enclose also the armature and commutator. As shown, this casing projects inwardly, at the backs of the pole-pieces, to constitute supports for the core 18, and is correspondingly hollowed out as regards its exterior, as indicated at 27, so as to lessen the weight of the structure.

Various methods of controlling motors, constructed in accordance with this invention, may be employed, it being preferable, as above stated, to vary the e.m.f. applied to the motors. For this purpose a transformer may be interposed between the motor and the supply mains, and the e.m.f. of the secondary may be varied by varying the number of windings of the primary or secondary, or varying their magnetic relationship in a manner well known in the art. Either a two-coil transformer or an auto-transformer may be employed. Another very convenient means consists in the employment of a three-coil transformer, the third coil of which is connected with the primary coil of a secondary transformer, the secondary coil of which is in series with the secondary coil of the main transformer, as above described. Rheostats or similar adjusting means may obviously be employed in addition to or instead of the means for varying the voltage.

The claims of Mr. Lamme's English patent are as follows:

1. A single-phase alternating-current series-wound motor, in which the ratio of the field-magnet self-induction to the armature counter e.m.f. is approximately equal to the ratio of the line alternations to armature alternations, substantially as described.

2. A single-phase alternating-current series-wound motor having a closed-coil parallel-wound armature with relatively high resistance leads connecting the armature coils with the several commutator bars, and a field-magnet the poles of which have slots transverse to the direction of rotation of the armature and with or without a closed conductor inserted in one of the slots and extending through approximately the central portion of the pole, substantially as described.

3. For use with single-phase alternating electric currents, a series-wound motor having the ratio of the number of its field poles to the number of current alternations per minute approximately as 1 to 250, and having a ratio of field ampere-turns to armature ampere-turns approximately as 20 to 27.

4. Electric motors for use with single-phase alternating currents constructed substantially as described with reference to the accompanying drawings.

TELEPHONE ENGINEERING.

Cable Splices.

BY F. J. DOMMERQUE.

In underground construction splices are required at every manhole, and these occur about every 300 or 400 feet. Splices are of great importance in cable work, because it is usually at the splice where the element of danger for the cable lies. As pointed out in an earlier article, telephone cables rely upon air and paper for insulation material between conductors; and both the air and the paper must be kept dry, or else the insulating qualities will fall below the requirements for good service and the cable will be spoiled. The lead sheath keeps moisture out. If the sheath is cut for a splice, or if two pieces of cable the ends of which are hermetically sealed are opened for splicing, an opportunity is afforded for the entrance of moisture from the surrounding atmosphere and it is remarkable how much moisture is absorbed from the air by the cable, and how quickly it is absorbed. Therefore, dry days should be chosen for making splices; in other words, summer time is the best time for cable work.

It undoubtedly pays to choose experienced men for this kind of work, as one bad splice may spoil a whole section of cable. The time for splicing should be so chosen that all splices can be finished before the work is left in the evening. It is possible in a case of emergency to cover up the end of a cable which is being spliced and boil it out the next morning and then finish the splice, but that is a risky proceeding. It has been claimed as a point against the use of 400-pair cables that splices cannot be easily made without leaving them open over night . A splicer who knows his business can make a good 400-pair splice in a day if he starts in in proper time.

The description of the making of a splice is not sufficient for actual work. A great deal of practice is required to do good work, and bad work on splices should never be tolerated. Cables are only cut for splices when a defective piece has to be cut out. Generally the two sealed ends of two cables of the same size are to be spliced, or one end of a large cable is to be joined to the ends of two or three small cables. When splicing, precaution must be taken that all wires of the same color are joined together. It is not necessary to pay any attention to the numbering of the pairs as the numbering will be taken care of when testing out. When making measurements for ordering cables, splices must be counted in. Three feet should be allowed at each end of a cable which may be used for a splice, a terminal or a pothead connection, in addition to the ends which have to be thrown away in any case.

To splice two cables of the same size, proceed as follows: Cut back the lead sheath of the cables for a length sufficient to give free conductor space on each cable and to reach over the splice; the space required depends on the size of the cables to be spliced. Mark off where the sheath is to be cut and cut around it with an ordinary knife until it is cut nearly through, then bend the cable a few times backward and forward which will cause the sheath to break. Take off the sharp edge left after the short piece of detached sheath is stripped off and remove the paper packing from the conductors, leaving about ¼ inch standing so as to prevent the sheath from cutting the insulation of the wire. Then bind the two cable ends with cotton wicking at the point where the cable emerges from the sheath, drawing the cotton tight enough to prevent the twisted pairs from shifting and to keep the end tight. Then dip the ends of the cable up to and including the cotton wrapping into boiling paraffine (the paraffine being kept boiling during the whole process of making the splice), leaving the ends immersed until no more bubbles are noticed. Then the lead sleeve which is to cover the splice after it is finished, is slipped over one end of the cable far enough back so as to be out of the way while work is being done. These sleeves are obtained from the cable manufacturer and are about ¾ inch to 1¼ inch larger in diameter than the cable, according to its size, and long enough to allow of ample space for the splice and an overlap of 1½ inch or more at each end for the wiped joint, the length increasing proportionately from 18 inches for a 10-pair cable to 40 inches for a 400-pair cable, according to gauge of cable conductor and experience of cable splicer; less experienced men need longer sleeves.

The accompanying table gives the standard size of sleeve for No. 20 B. & S. gauge lead-covered cables used by some prominent telephone companies:

TABLE I.—STANDARD SLEEVE SIZES FOR NO. 20 LEAD-COVERED CABLE.

Size of Cables.	Inside diam. of Sleeve.	Length of Sleeve.
10-pair	1 inch	18 inches
25 "	1½ "	18 "
50 "	1½ "	18 "
75 "	2 inches	18 "
100 "	2 "	18 "
150 "	2½ "	22 "
200 "	3 "	22 "
300 "	3½ "	22 "
400 "	4 "	24 "

For No. 19 B. &. S. gauge cable a size larger than that specified in the table is used.

Many construction men use a frame (like a box with sides and top removed) to hold the two cable ends in place while the splice is made. Such a frame is shown in Fig. 1. The cable ends are then laid into this frame and secured the proper distance apart, which depends upon the length of the lead sleeve. For small cables a distance three inches shorter than the length of the sleeve will be sufficient; for larger cables four inches should be allowed. Now the ends of the conductors have to be turned back so as to get them out of the way. In turning them back, do not disturb the twists in the pairs. Then begin splicing together with the innermost pair by cutting one conductor of the pair of the one cable about 4 inches, and the other conductor of the same pair about 2 inches, from the lead sheath which requires the corresponding pair to reach nearly over the whole splice. Undo the twist of each pair for about 3 inches. Slip a paper tube, from 2 to 3 inches long and soaked in boiling paraffine over one conductor of each pair; then clean each conductor for about an inch back and bend the cleaned ends of the same colored insulation at right angles from the direction of the cable and twist these ends together. Clip off any surplus and bend the twisted end back parallel to the other wires and draw the paper tube over the joint to cover it evenly.

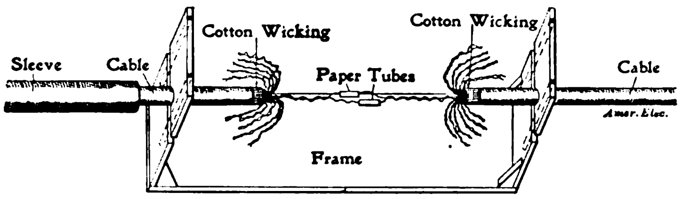


FIG. I.—FRAME FOR USE IN SPLICING CABLES.

Proceed in the same way with the two wires of the same color in the same pairs, but offset the splice enough so that the paper sleeve of one conductor, after splicing, clears the paper sleeve of the other conductor. Then take the next pair and proceed in the same way. As it will be remembered from the description of the cables, there are a number of layers of pairs grouped around a central pair. In order to avoid bunches in the splice, the pairs in each group may be all cut to the same length and spliced, offsetting the groups by about 3 inches. In this manner the joints will be well distributed over the whole splice while the grouping is not disturbed.

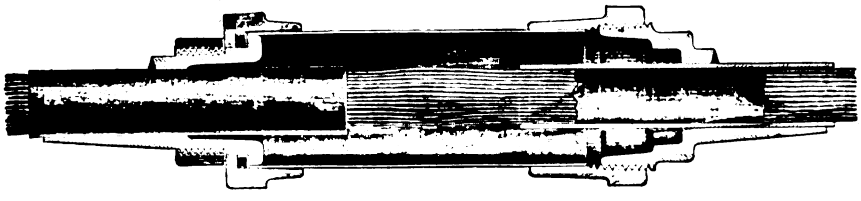


FIG. 2.—LONGITUDINAL SECTION OF CABLE CONNECTOR.

After all joints are made, boiling paraffine is ladled over the splice until all bubbling in the liquid paraffine has ceased. Then twine is wound around the splice to keep the joints in place; or some splicers prefer to wind a strip of white cotton about an inch wide around it and then boil it out again. Next the sleeve is drawn over the splice so as to overlap both ends equally, with 1½ inches of overlap at each end for the smallest size cable and 2 inches or more for larger cables. The ends of the sleeve are then hammered down with a plumber's maul until they grip the lead sheath tight; then the ends are scraped with a plumber's scraper and the process of wiping the joints can begin. First a paper ribbon is pasted around the cable one inch below the sleeve and another one around the sleeve itself. The splicer then pours with the spoon he is holding in his right hand carefully hot solder over the joint, catching what flows off with the piece of leather he holds in his left. The hot solder must be ladled back and forth on the cable and sleeve so as to get it hot enough to wipe without melting the sheath through. The leather in the left hand must retain only as much hot solder as is required to heat the joint enough from below to be able to wipe. As soon as solder and lead mix together, the splicer ceases to pour and wipes the joint, watching it carefully for cracks or blow-holes. The solder used for splicing is the so-called half and half solder, consisting of equal quantities of tin and lead. In Germany they use a solder consisting of 800 parts of lead and 400 parts of tin, by weight, which are melted in a solder pot, stirring with an iron rod. Then 5 parts of sulphur are added and as soon as the sulphur is burned, 3 parts of resin and 5 parts of tallow are mixed; when everything is melted the slag is skimmed off. All "parts" are by weight, and may be ounces, grams, or whatever unit one likes.

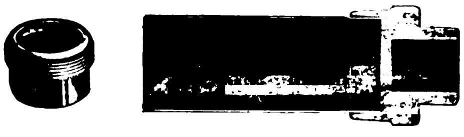


FIG. 3.—POT HEAD.

Finally the splice is to be filled with hot paraffine. For that purpose a hole is tapped into the sleeve (for large cable splices two holes are tapped, each about one-third the distance from the ends of the sleeve) and hot parffine is poured into the hole (alternately into each hole when two holes are used), or the whole splice is immersed in hot paraffine until the sleeve is entirely filled. When the sleeve is cool the holes are soldered up.

A Y-splice is used when two cables are connected to the main cable. It is not necessary that the two cables be of smaller size than the main cable, as it is often advisable to let the main cable continue in its full capacity and take a part or the whole of the conductors to some distributing point to serve a number of subscribers, having the same number of conductors also terminate at some other distributing point so as to obtain the possibility of cutting in subscribers at either point, which renders the plant more flexible and in many cases may effect a considerable saving in operation. This method is known as "multiple cabling." Although this method is frequently employed in aerial cable work, it is mostly resorted to in underground cabling. So far as the splicing is concerned, the difference consists in that in the multiple cabling two conductors are connected to one conductor in the main cable, while in the case of dividing the main cable into two branches only one conductor of one of the branch cables is connected to one conductor of the main cable.

Frequently in multiple cabling a double pothead construction is used instead of a Y-splice. The double pothead has the advantage of easier testing and of the possibility of cutting out one section without disturbing the main cable, when any trouble on that particular section should evolve. The double pothead method has its principal advantage where party lines are in use. The Y-splice of course requires also a pothead, but one only, for connection to the terminal.

A pothead is nothing less than a splice, only in this case one end of the splice is not wiped, but attached to a terminal. The cable end is treated in the same manner as the splice just described. In this case, however, no other cable is joined to the paper cable, but a rubber-covered wire is jointed to each wire in the paper cable. In potheading no paraffine is required except that the paper-covered wires after removal of the lead sheath may be doused with boiling paraffine to keep the paper from untwisting and exposing the wire. The rubber-covered wire is usually of No. 19 B. & S. gauge and the pairs are twisted, one wire being black and the other one red. The pothead sleeves vary in size according to the size of cable. Table II gives their approximate dimensions.

TABLE II.—POTHEAD DIMENSIONS.

10 pairs	Inside diam.	½ in. larger than cable	18 ins. long.
25 "	" "	¾ " " " "	20 " "
50 "	" "	¾ " " " "	20 " "
75 "	" "	1 " " " "	22 " "
100 "	" "	1 " " " "	22 " "
150 "	" "	1¼ " " " "	24 " "
200 "	" "	1½ " " " "	24 " "
250 "	" "	1½ " " " "	24 " "
300 "	" "	1¾ " " " "	26 " "
400 "	" "	2 " " " "	28 " "

The splicer as a rule knows best what dimensions he requires and generally uses his own judgment.

After the splice is made and one end wiped, the pothead must be sealed at the open end. For this purpose, a compound is used, consisting of pitch, asphalt and resin boiled together until it runs freely. In place of pitch and asphalt a prepared insulating mixture, such as "D. D." or Chatterton compound, may be used. This compound is poured into the pothead while boiling and the pouring is continued until the boiling stops and no more bubbles appear. Then a collar is put on by wrapping a piece of leather around the wires and fastening it with rubber tape. The collar is pushed down into the pothead until it is half way in and half way out. Then a little more of the compound is poured in and finally the edge of the lead sheath is trimmed down with a plumber's maul to fit closely against the leather collar; the tapping with the maul should be done lightly so that the edge of the sleeve will gradually turn over and form into a smooth curve. Then the head is fastened in the terminal box.

Lately the New Haven Novelty Machine Company has put on the market a device which it calls "Novelty Cable Connections," designed to do away with the wiped joint which is so trying to make, especially when it has to be done on a pole or on a cable car. The new device is a brass tube provided at the ends with nuts and a gravity joint. Figs. 2 to 5 illustrate some of the connectors of these makers; the following description is quoted from the company's literature:

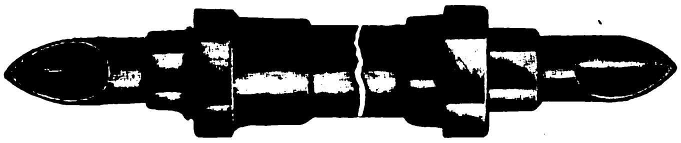


FIG. 4.—PERSPECTIVE VIEW OF CABLE CONNECTOR.

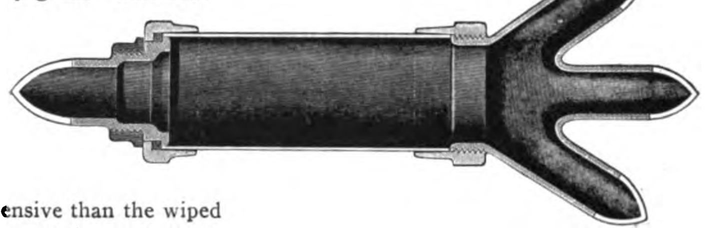


FIG. 5.—BRANCHED CABLE CONNECTOR.

The problem of making the Novelty cable connections absolutely moisture proof has been solved by means of connecting the fittings to the cable by the use of the Novelty gravity joint. The application is simply by heating the solder and allowing it to flow by gravity down the tinned inclined lip or hub, and then to pass the heated iron or blow torch underneath the lip, which causes the solder to flow. This can be done very quickly, does not require skilled labor, and, as it adheres to the cable and supports it a longer distance, is much stronger than the ordinary wiped joint. The Novelty pothead also has the advantage of the slidable sleeve, and further, should occasion require, the pothead being made of brass, it can be heated and the composition contained therein allowed to run off. The pothead further commends itself to users for the reason that it is not necessary to bend the pipe in order to wipe the joint, as at present, nor carry the molten metal up the poles. All that is required is a hot iron to cause the solder in the hub to flow. In cold weather the "compound" or paraffine oftentimes hardens, flowing into the pothead too thick, with the consequent result that it will not be properly or evenly distributed. By the Novelty system, the pothead being made of brass, a blow torch can be applied, which will heat the compound to a boiling point, and thus insure the desired result. This could not be done with the lead pothead. The ends of the sleeve are secured in different ways by the use of the lock nut and tapered screw end. Although it is not absolutely necessary to use any compound in order to make the tapered end moisture proof, the use of Dixon's Graphite Compound is recommended (it having been found by experience that this will not set) in order that the sleeve may be more easily removed at some future time. On the lock nut end it will be noticed that the shoulder of the gravity joint inside the sleeve is milled down and when the lock nut is tightened, this milled shoulder bears on a soft metal gasket, which is an integral portion of the sleeve itself. By removing the lock nut the splice may be opened at any time and as easily closed.

The makers also state that "by the old system it is impossible to open a splice for inspection or test without incurring an expense greater than the first cost of installation, to say nothing of the loss of time and impairment of service caused by the operation." It is certainly true that this Novelty splice has the advantage in testing, but as the old splice is mostly near a terminal the advantage is not so very great. This Novelty splice is more expensive than the wiped joint splice, and the latter has stood the test of time, while the Novelty splice has still to prove its merits. In small plants, however, where only a few splices and potheads are required, it may be difficult and expensive to obtain the services of an experienced cable splicer and the Novelty splice may prove economical on the whole.

◆

CHIMNEYS.

BY CHAS. L. HUBBARD.

The form and size of the chimney is a most important factor in the design of a boiler plant, and should receive careful consideration. The draft of a chimney is due to the difference in weight of the hot gases inside of the flue and of the cold air surrounding it. The draft is usually expressed in inches of water. The intensity of draft is measured by connecting one end of a U-tube containing water with the chimney flue while the other end is left open to the atmosphere; the difference in the level of the water in the two legs of the tube will show the intensity of the draft. A difference of ¼ inch indicates a moderate draft, ⅜ to ½ inch a fairly good draft, and ¾ to 1 inch a strong draft (not forced).

The required area of cross-section for a given chimney depends upon its height and the amount and kind of fuel to be burned. The conditions which affect chimney draft are so numerous and difficult to treat theoretically that it is generally considered best to use empirical formulas derived from the study of existing plants.

The formulas most commonly used are those of Kent, Christie and Gale, of which the first two are the simplest to apply. The constant used in Kent's formula is based upon the assumption that 15 pounds of coal will be burned upon each square foot of grate surface per hour under the draft produced by a chimney 80 feet high. This formula in its different forms is given below:

$$E = \frac{.3\,H}{\sqrt{h}}, = A - .6\,\sqrt{A}$$

$$H = 3.33\,E\,\sqrt{h}$$

$$S = 12\,\sqrt{E} + 4$$

$$h = \left(\frac{.3\,H}{E}\right)^2$$

in which

E = effective area in square feet,
A = actual area in square feet,
H = horse-power of boiler plant,
S = side of square in inches,
h = height of chimney in feet.

In computing the "effective" area (E) from the actual area (A) it is assumed that the gases for a depth of 2 inches next to lining have no velocity, because of friction. That is, the actual diameter of a round chimney, or the side of a square chimney, should be 4 inches greater than the diameter that corresponds to the area required to carry off the gases. Table I

TABLE I.—RELATION BETWEEN CHIMNEY DIMENSIONS AND BOILER HORSE-POWER.

Diameter in inches.	Height of Chimney in Feet.											Effec. area, sq. ft. E	Actual area, sq. ft. A	Side of square of approx. same area.
	50	60	70	80	90	100	110	125	150	175	200			
	Boiler Horse-Power.													
18	23	25	27	...	...	....	....	....	....	....	....	.97	1.77	16″
21	35	38	41	...	...	....	....	....	....	....	....	1.47	2.41	19″
24	49	54	58	62	...	....	....	....	....	....	....	2.08	3.14	22″
27	65	72	78	83	...	....	....	....	....	....	....	2.78	3.98	24″
30	84	92	100	107	113	....	....	....	....	....	....	3.58	4.91	27″
33	..	115	125	133	141	....	....	....	....	....	....	4.47	5.94	30″
36	..	141	152	163	173	182	....	....	....	....	....	5.47	7.07	32″
39	..	...	183	196	208	219	....	....	....	....	....	6.57	8.30	35″
42	..	...	216	231	245	258	271	....	....	....	....	7.76	9.62	38″
48	..	...	...	311	330	348	365	389	....	....	....	10.44	12.57	43″
54	..	...	...	363	427	449	472	503	551	....	....	13.51	15.90	48″
60	..	...	...	505	539	565	593	632	692	748	....	16.98	19.64	54″
66	..	...	...	...	658	694	728	776	849	918	981	20.83	23.76	59″
72	..	...	...	...	792	835	876	934	1023	1105	1181	25.08	28.27	64″
78	..	...	...	...	...	995	1038	1107	1212	1310	1400	29.73	33.18	70″
84	..	...	...	...	...	1163	1214	1294	1418	1531	1637	34.76	38.48	75″
90	..	...	...	...	...	1344	1415	1496	1639	1770	1893	40.19	44.18	80″
96	..	...	...	...	...	1537	1616	1720	1876	2027	2167	46.01	50.27	86″

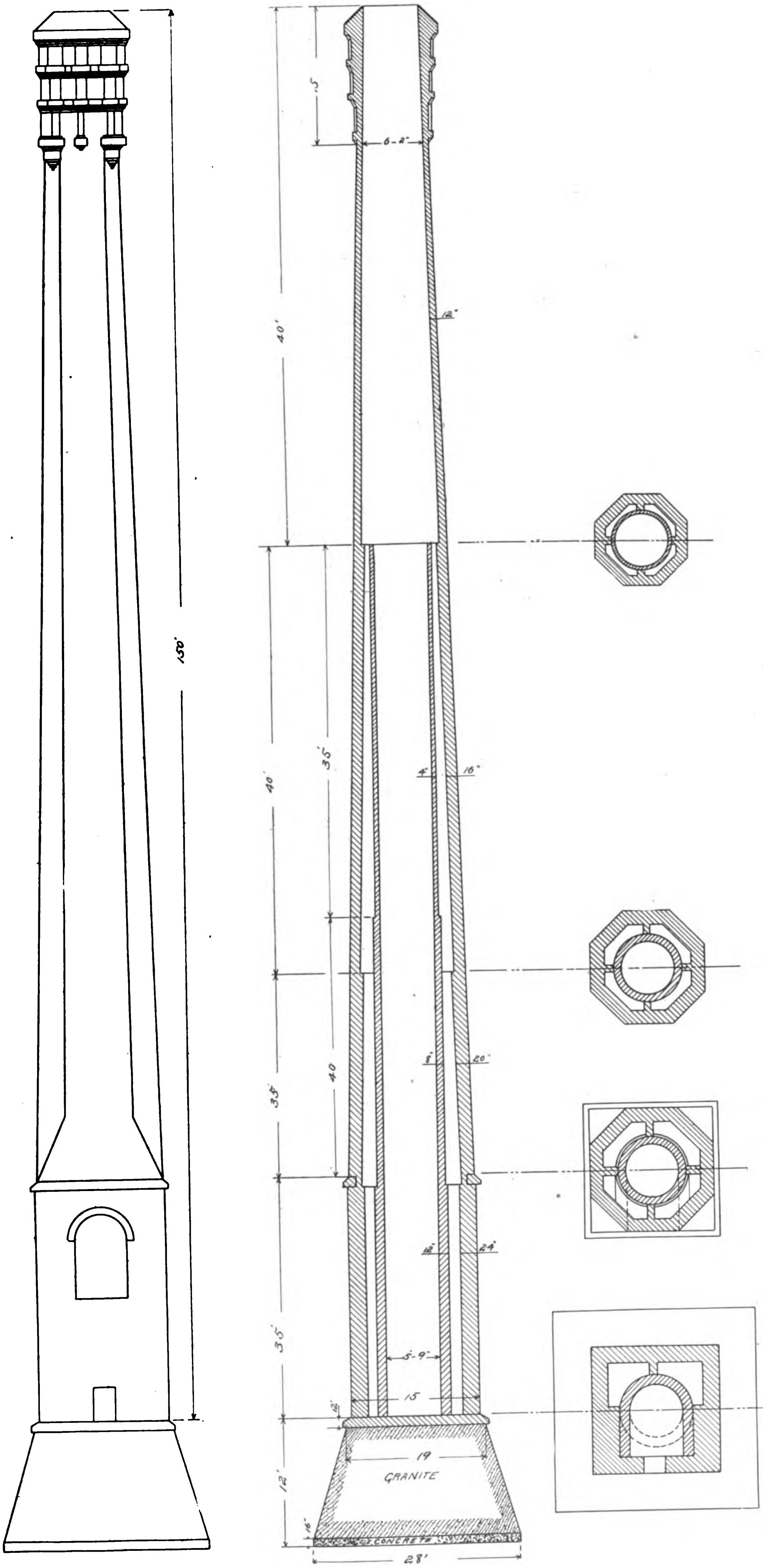


FIG. I.—ELEVATION AND SECTIONAL VIEWS OF CHIMNEY.

has been computed by this formula and will be found convenient to use. In this table it has been assumed that 5 pounds of coal will be burned per horse-power per hour. To find the number of pounds of coal that can be burned per hour by natural draft with any chimney dimensions given in the table, multiply the corresponding horse-power by 5. Only that part of the table is filled in which corresponds to ordinary proportions between area and height, and these general relations should be followed if calculations are made from the formula.

Christie's formula is

$$H.P. = 3.24\ A\ \sqrt{h},$$

it being assumed that 4 pounds of coal are burned per horse-power per hour. The notation here is the same as in Kent's formula.

In looking over the chimney plans of a number of important power plants, the heights were found to vary from 20 to 30 times the diameter of the flue, and a chimney designed with proportions within these limits should under ordinary conditions give a good efficiency, and at the same time present a good appearance.

Another method which is sometimes used is based upon the relation between the grate and chimney areas. Common practice has shown that good results may be obtained if the area of the chimney flue is made about one-eighth of the total area of all the grates connected with it. The required height of chimney to produce different rates of combustion may be obtained by the following formula:

$$\sqrt{h} = \frac{F\ w}{10\ A}$$

in which

h = height of chimney in feet,

F = area of boiler grate surface, in square feet,

A = internal area of chimney flue, in square feet,

w = pounds of coal burned per hour per square foot of grate surface.

The formula will give approximately correct results for moderately free-burning bituminous and medium to large anthracite; for free-burning bituminous coals, deduct 10 per cent from height; for slow-burning bituminous, add 10 per cent; for pea coal add 15 per cent; and for No. 3 buckwheat add 25 per cent.

Some engineers determine the height of chimney by the grade of coal to be used and then compute the required flue area by one of the methods already given. The following heights have been found to give good results in plants of moderate size, and to produce sufficient draft to force the boilers from 20 to 30 per cent above their rating:

With free-burning bituminous coal, 75 feet; with anthracite of medium and large size, 100 feet; with slow-burning bituminous coal, 120 feet; with anthracite pea coal, 130 feet; with anthracite buckwheat coal, 150 feet. For plants of 700 or 800 horse-power and over, the chimney should not be less than 150 feet high regardless of the kind of coal to be used. It will be seen that the foregoing rule gives a somewhat higher chimney than the preceding formula, and for this reason, is undoubtedly better adapted to power work, where it is frequently desired to force the boilers or to change the grade of fuel. For heating purposes, or where the requirements are likely to remain more nearly constant, the formula may be used with suitable corrections for the grade of coal to be burned, as already stated.

It will be found for a given area that a round chimney will have a greater capacity and also present less resistance to the wind, but in ordinary building construction the flue is usually of rectangular outline, especially in the case of smaller plants, although iron or steel stacks of circular section are often used. In the construction of brick chimneys it is better to make the inside walls entirely separate from the outside, both in order to permit expansion of the inner wall and also to secure the advantage of the poor heat-conducting air space between the inside and outside walls. Such construction is common for the chimneys of power plant stations, but is not ordinarily applied to those in other buildings nor in plants for heating purposes only.

The foundation of a large chimney is of great importance and should be laid out under the direction of an experienced engineer. The base of the foundation should be of such size that the pressure per square foot will not be over 1 ton for a soft clay bed nor over 2 tons for stiff clay, well-packed sand or loam. These loads are often exceeded in building foundations, but should not be in the case of chimneys. Where the soil is of low bearing power, pile foundations should be used, especially for large chimneys. The piles should be driven on 2 to 2½-foot centers and the tops cut off below the level of the surface water. A layer of concrete 2 or 3 feet in thickness should be laid over the piles, allowing their tops to extend well up into it, and on top of this should be placed the regular foundation of brick or stone.

In computing the weight of a chimney, the following figures may be taken as a guide. Granite masonry weighs from 150 to 175 pounds per cubic foot, and brick work from 120 to 130 pounds. The external diameter or breadth of a chimney at the base should be at least one-tenth the height, unless it is supported by some other structure. The taper should be from ⅛ to ¼ inch per foot in height on each side.

Regarding the outer shell, the following approximate method may be used for determining the thickness of walls. If the inside diameter at the top is less than 3 feet the walls may be 4 inches thick for the first 10 feet, and increased 4 inches for each 25 feet downward. If the inside diameter is more than 3 feet and less than 5 feet, begin with a wall 8 inches thick, increasing 4 inches for each 25 feet downward. If the diameter is over 5 feet, begin with a 12-inch wall, increasing below the first 10 feet as before. The lining or core may be 4 inches thick for the first 20 feet from the top, 8 inches for the next 30 feet, 12 inches for the next 40 feet, 16 inches for the next 50 feet, and 20 inches for the next 50 feet. Using this method for an outer wall 200 feet high and assuming a cubic foot of brick work to weigh 130 pounds, it gives a maximum pressure of 8.2 tons per square foot of section at the base; while a lining 190 feet high would have a maximum pressure of 8.6 tons per square foot. The safe load for brickwork may be taken at from 8 to 10 tons per square foot, although the strength of best pressed brick will run much higher.

When the thickness of walls is determined as above, it is well to take sections of the chimney at different elevations and compute the weight of brickwork above, and see what the pressure per square foot of section is at these points. The lining of a chimney carries its weight only, while the outer shell must be made stable against wind pressure also. Power to withstand the overturning force of the wind requires a certain relation between the height, breadth, weight and form of chimney. This is expressed in the formula

$$W \geqq \frac{C\,d\,h}{f},$$

in which

$$C = \begin{cases} 56 \text{ for square chimneys,} \\ 35 \text{ for octagon chimneys,} \\ 28 \text{ for round chimneys,} \end{cases}$$

f = breadth or diameter at base, in feet;
d = average breadth or diameter, in feet;
h = height in feet;
W = weight of chimney in pounds.

The external form of the top is a matter of appearance and may be designed to suit the taste; it should, however, be protected with a covering of tile or cast-iron plates to shed the rain and keep water from penetrating the brickwork. Iron ladders, either inside or outside the flue, and lightning rods are accessories which should be added to tall chimneys.

The inner core or lining is usually built of fire brick for a portion of its height, and it may be from two-thirds to three-fourths of the total height of the chimney, although some engineers prefer to carry it up the full height. In any case, it should be entirely separate from the outer wall. Openings must be left near the base for smoke pipe and clean-out. These may be either arch over the tops or provided with iron bearing bars. Fig. 1 will be found useful as a guide in the design of new chimneys.

Iron stacks of boiler plate are quite commonly used at the present time. These are of two kinds; the first is designed simply to carry its own weight, and is supported against wind pressure by guying it. The second kind is made stable by heavy foundations and anchor bolts. Only the first will be discussed here. Iron stacks are made up in sections like the shell of a boiler, the end of one section being slipped into the next and the joint riveted. Sometimes the sections are butted together and a covering ring placed over the joint and riveted to each piece. The stack usually rests upon a cast-iron ring or plate from 1 to 2 inches in thickness, which in turn is supported upon a foundation of stone or concrete. When the side of the stack is cut away for connecting the smoke pipe, suitable means should be taken to strengthen the shell at this point. This may be done by riveting angle or tie bars to the plates at the sides of the opening, extending them for some distance above and below it. Stiffening pieces are sometimes placed across the top and bottom of the opening, with a supporting piece placed vertically across its center. The following table gives usual and safe dimensions for supported stacks.

TABLE II.

Diam. of chimney in ins.	Height in feet.	Thickness of shell for first half of height, in ins.	Thickness of shell for sec. half of height, in ins.	Diam. of rivets, in ins.	Pitch of rivets, in ins.	Total weight of stack, in lbs.
15	40	¼	3/16	½	3	1400
18	45	8/16	¼	⅝	3	2500
20	50	5/16	¼	⅝	3	3000
24	60	5/16	¼	⅝	3	4300
30	75	⅜	5/16	¾	3	8300
36	90	⅜	5/16	¾	3	11,750
42	105	⅜	5/16	¾	3	15,700
48	120	⅜	5/16	¾	3	21,450

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Areas of Safety Valves for Steam Boilers.—The size of safety valves required on boilers is usually determined by the area of the grate surface. The United States Government law for marine boilers is, generally speaking, accepted as the standard. That rule is, "one square inch of safety-valve area to every two square feet of grate surface," and "where a spring-loaded or pop-valve is used, one square inch of safety-valve area to every three square feet of grate surface." With the various types of boilers in use, no doubt exists that this rule gives good results. But there are cases where the rule does not apply. In a puddle mill, for instance, the boiler has no grates, being operated solely by the waste heat from the puddle furnace. Boilers at blast furnaces also use waste gases for the stoves, and the grate surface is very small indeed, due to very little coal being used, and that only when the gas is not available. In the sections where natural gas is found and used, it is customary to cover up the grate with sheet iron and brickwork while using gas. With the use of oil it is the same. Weighing all these facts, it is clear that, at least where these fuels are used, the safety-valve area must be determined from the heating surface, as the grate surface, if not entirely absent, is absolutely of no value. We may dispense with grates, but we cannot dispense with safety-valves, as the United States Government rule inferentially suggests. Accepting, then, the basis of heating surface for determining the safety-valve area, and assuming that pop-valves are used, it is probable that in order to afford sufficient release, the ratio of heating surface to safety-valve area should be about 100 feet of the former to 1¼ square inches of valve area, which would call for a 4-inch pop-valve in a boiler with 1000 feet of heating surface. With larger boilers, it would be best to have two valves rather than increase the size of valve above 4 inches, one being set to blow off at a steam pressure slightly under the other.—*Exchange.*

Fan Motors for 1904

Except for the development of the swinging or oscillating fan-motor, the number of improvements in the design and construction of these little machines grows steadily less and less each year, which is, of course, a perfectly natural result of the serious engineering skill bestowed upon the problem of producing reasonably efficient apparatus which shall be inexpensive and at the same time require no attention for months in succession. The General Electric Company has brought out this year a convertible type of machine which may be changed from a desk fan-motor to a bracket motor by the use of a small "adapter."

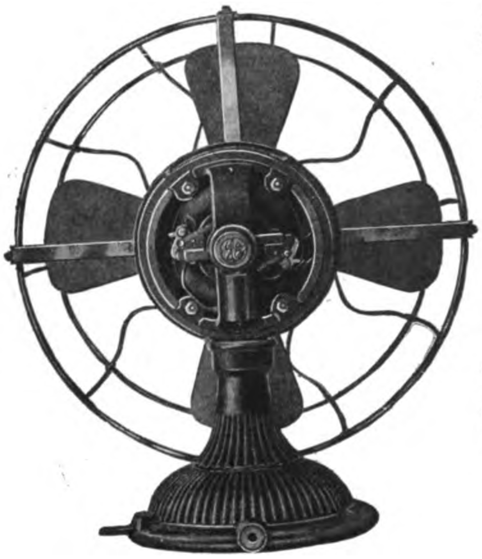


FIG. I.—MOTOR WITH CAP REMOVED.

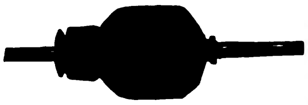


FIG 2.—G. E. DIRECT-CURRENT ARMATURE.

The general construction of the G. E. machines is similar to that of last year's designs. The direct-current motors have bipolar laminated field magnets, enclosed dust-proof frames, swivel and trunnion mounting, etc., as before. The armature discs are twisted on the shaft to prevent disturbance of the magnetic field and humming. The brushes and holders are easily accessible by removing a shield on the back of the motor frame, leaving the machine in running condition, as indicated by Fig. 1. Fig. 2 illustrates the armature construction just mentioned. The brushes are of unusually large size and are fed through brass boxes by means of spring-actuated brass fingers pivoted so that the tips of the fingers describe a rather flat arc, to the center of which the axis of the brush is tangential.

Three running speeds are made available by means of a rheostat and switch mounted within the pedestal base. Fig. 4 shows the under side of the porcelain disc on which is mounted the regulating switch. These motors are built with 12-inch and 16-inch fans. The speeds of the 12-inch fans are 900, 1200 and 1600 r.p.m., and the power required is 32 watts, 41 watts and 51 watts, at the respective speeds named. The 16-inch fan runs at 800, 1100 and 1500 r.p.m, and requires 60, 80 and 100 watts, respectively, at these speeds. Both sizes are wound for 115 and 230 volts.

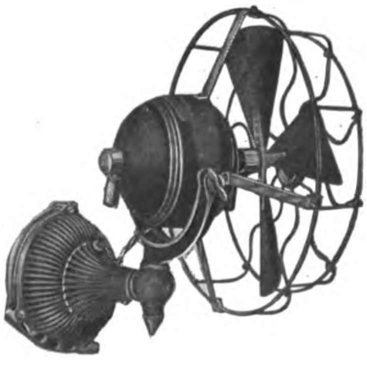


FIG. 3.—G. E. BRACKET MOTOR.

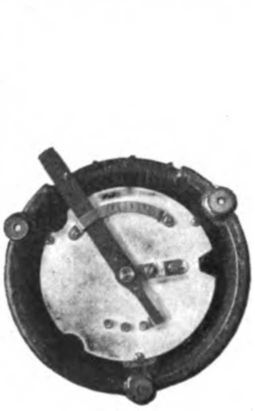


FIG. 4.—G.E. SWITCH

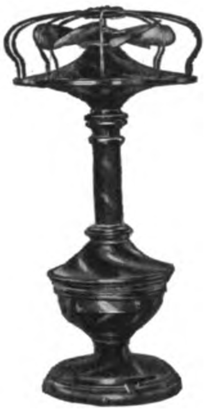


FIG. 5.—G.E. RADIAL FAN

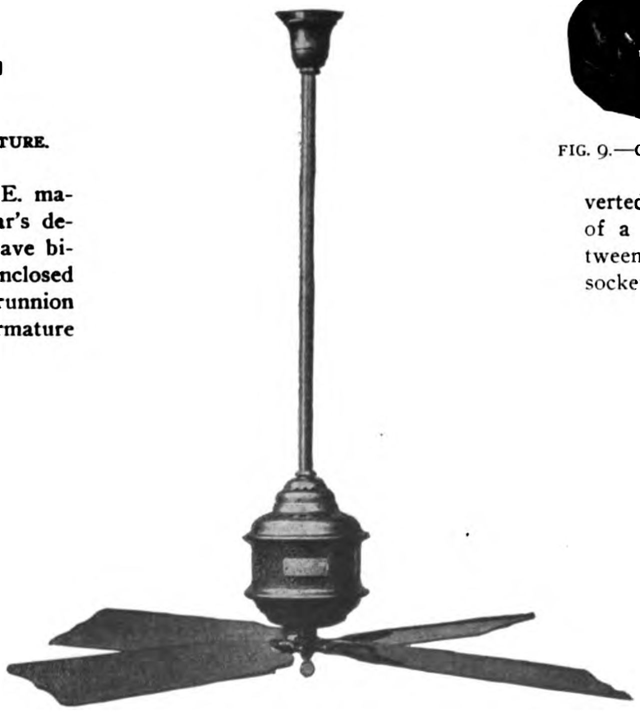


FIG. 6.—G. E. DIRECT-CURRENT CEILING FAN MOTOR.

Fig. 5 illustrates a special form of fan motor, recently brought out and known as the "radial" fan, the distribution of the air being substantially radial to the axis of the machine. This distribution is accomplished by means of the curved deflecting plate shown immediately beneath the fan blades; the fan revolves so as to throw the air downward against the deflecting plate. The motor, of course, is mounted in the semi-spherical casing near the base of the standard. The maximum speed is 2000 r.p.m. and the machine is wound only for 115 volts. It is intended chiefly for use at banquets and similar service.

The General Electric alternating-current fan motors are of the squirrel-cage induction type. The regulating device is mounted in the pedestal base instead of in the back of the motor casing as formerly, and is connected to the motor by means of a flexible cord, as indicated in Fig. 7. This illustration shows the exterior appearance of the 12-inch swivel and trunnion motor, and Fig. 8 shows the same motor converted into the bracket type by the addition of a compact universal joint inserted between the shank of the trunnion and the socket in the top of the pedestal. The stator is of the usual laminated construction, with four polar projections; these are wound as usual in direct-current machines, and also have shading coils to enable the motor to start up from rest. Fig. 9 shows

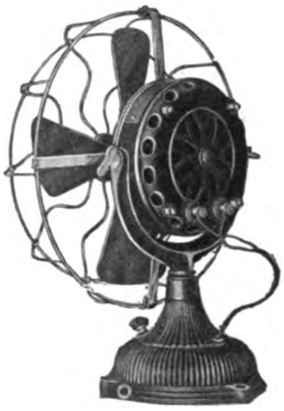


FIG. 7.—G. E. ALTERNATING-CURRENT MOTOR.

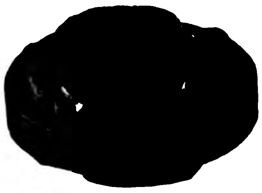


FIG. 9.—G. E. FIELD MAGNET.

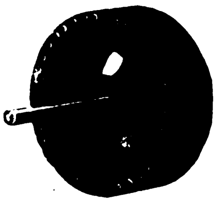


FIG. 10.—G. E. ROTOR.

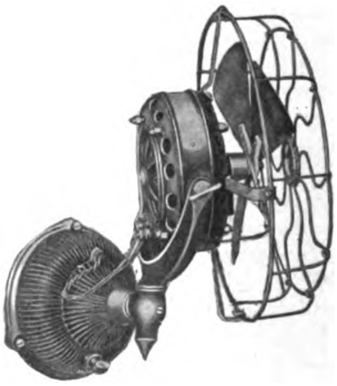


FIG. 8.—G. E ALTERNATING-CURRENT BRACKET MOTOR.

the magnet and coils complete, and Fig. 10 shows the squirrel-cage rotor. The rotor conductors are not insulated from the core. These machines are built for the standard frequencies and voltages and with 12-inch and 16-inch fans. The normal running speeds are 900 and 1550 r.p.m. for the 12-inch size and 900 and 1400 r.p.m. for the larger machine. They require respectively 75 and 180 watts at full speed.

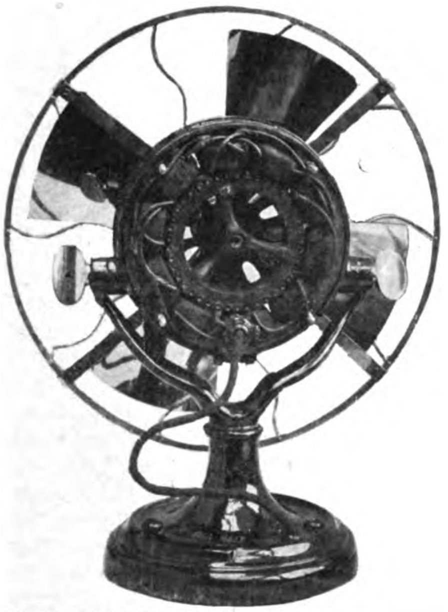


FIG. 11.—WESTINGHOUSE TEN-POLE DESK FAN-MOTOR.

The General Electric ceiling fan-motor is illustrated by Fig. 6. The blades have a sweep of 58 inches, and the machine may be operated at any one of three speeds. The motors built for 115 and 230 volts run at 125, 160 and 200 r.p.m., and the 500-volt machine runs at 140, 170 and 200 r.p.m. All these motors take 108 watts at full speed.

The Westinghouse & Electric Manufacturing Company has brought out a new line of direct-current fan-motors this year, but they are unfortunately not ready for description as we go to press with this issue. The Westinghouse alternating-current fan-motors are similar to those of last year.

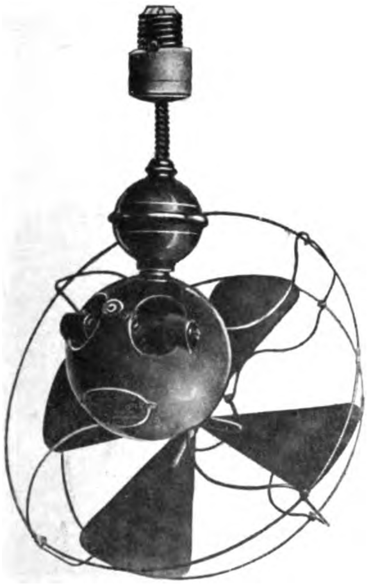


FIG. 14.—FT. WAYNE REVOLVING MOTOR.

The machine is an induction motor embodying no special features except the use of a rotor of unusually large diameter. Fig. 11 shows a 133-cycle machine, which, on account of the high frequency, has a large number of poles: ten. The field magnet or stator consists of a laminated yoke ring with integral poles mounted in a light cast-iron casing and wound with a sectional winding which is connected to the regulating switch so that the sections may be cut in or out of circuit to obtain different speeds. The rotor, Fig. 12, is obviously of the squirel-cage type. The rotor conductors are bare copper rods, with their ends soldered into heavy rings at the ends of the core. There is only one bearing, which is located between the rotor core and the fan, and this is lubricated by means of felt wicking in an oil reservoir beneath the journal.

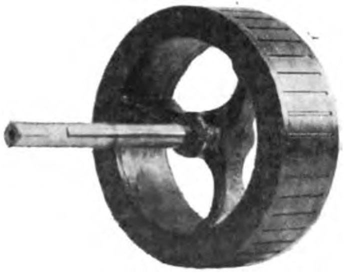


FIG. 12.—WESTINGHOUSE ROTOR.

These machines are built with 12-inch and 16-inch fans, and for 100-120 volts at each of the standard frequencies. The 12-inch 60-cycle fan requires 60 watts at low speed (which is 1000 r.p.m.) and 85 watts at full speed (1550); the 12-inch 133-cycle fan runs at 1200 r.p.m. on 50 watts and at 1350 r.p.m. on 65 watts. The speeds and power requirements of the 16-inch 60-cycle fans are 1000 and 1550 r.p.m. and 145 and 180 watts, respectively; the 133-cycle fans of this size run at 1200 r.p.m. on 87 watts and 1450 r.p.m. on 103 watts. The two speeds are secured by cutting in or out part of the field magnet winding, as previously mentioned, a switch for this purpose being located in the base of the pedestal.

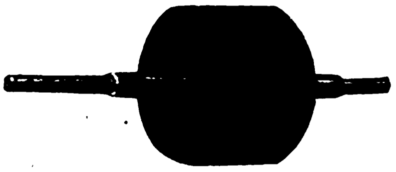


FIG. 17.—FT. WAYNE ROTOR.

FIG. 16.—HIGH-FREQUENCY FIELD MAGNET.

"Wood" fan-motors manufactured by the Fort Wayne Electric Works are made in three styles, for use in different locations, and in three voltages, one for direct current at 115 volts and another for 52 and 104 volts alternating current, or 60 and 140 cycles. The first style of fan-motor produced was a small stationary desk-fan as shown in Fig. 15. This fan-motor is exceedingly light for its output and makes a very neat appearance without taking up much room. The motor drives an 8-inch four-blade fan at 2200 r.p.m.; the 140-cycle alternating-current machine requires 40 watts and the direct-current and 60-cycle alternating-current machines each require 20 watts. The direct and alternating-current motors are exactly alike in appearance, and very similar in internal construction, excepting the high-frequency motor, which is of the squirrel-cage induction type. The 60-cycle and the direct-current motors have bipolar laminated field magnets with tapered pole-tips, and drum-wound slotted-core armatures, as illustrated by Figs. 18 and 18-a respectively. The high-frequency alternating-current motor has a four-pole laminated field magnet equipped with shading coils to assist in starting, as shown by Fig. 16. The rotor is of the usual squirrel-cage construction, except that the discs are twisted on the shaft so as to spiral the slots and reduce humming; see Fig. 17.

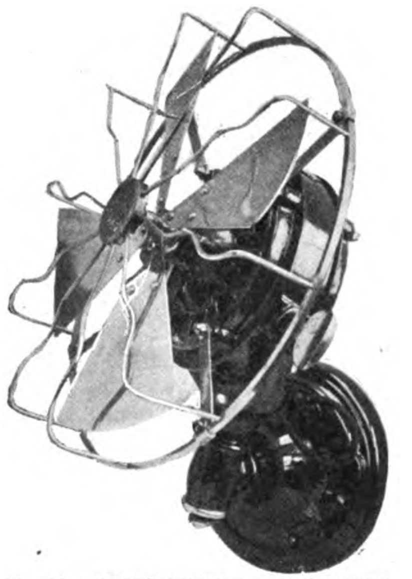


FIG. 13.—WESTINGHOUSE ALTERNATING-CURRENT BRACKET MOTOR.

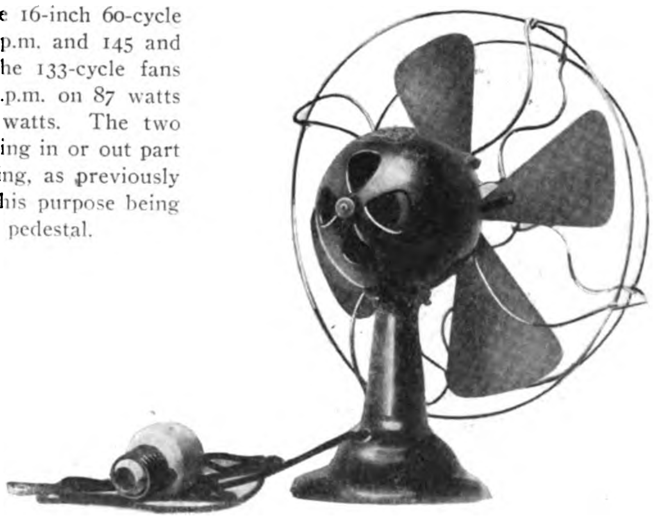
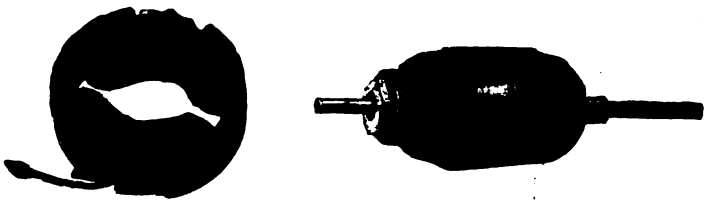


FIG. 15.—FT. WAYNE DIRECT AND ALTERNATING-CURRENT MOTOR.

The field laminations are individually japanned before being assembled and are



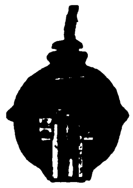


FIG. 18.—FT. WAYNE DIRECT-CURRENT AND 60-CYCLE FIELD MAGNET AND ARMATURE, FIG. 18-a.

FIG. 19.

riveted together with German silver to reduce eddy currents to a minimum. The magnet poles have projecting tips and the coils when pulled into place and bent into shape shown in the engraving are drawn into recesses above the pole tips. The coils are form-wound with silk-covered wire and after construction are shellacked, baked and taped. The armature coils of the commutator-type motors are form-wound, taped, shellacked and baked before assembling on the core, and the complete armature is baked. The core-slots are lined with an insulating fabric and the coils are held by a wedge in the upper part of each slot. The commutator is separate from the armature and assembled complete with its insulation and thoroughly baked and tested before the final assembling on the armature shaft. The brushes are rectangular in cross section and located in square brass tubes in which they are fed toward the commutator by means of helical springs. Adjustment of the spring tension is provided for in a screw set into the upper end of each brush tube. Contact between the brushes and brush box is obtained by a small sliding pressure spring on one side of the box which also prevents chattering by the brushes.

Fig. 14 illustrates a style of mounting employed by the Fort Wayne Electric Works which has met with general appreciation. The motor of this outfit is exactly the same as in the desk type, except as to the position of the point of support for the motor casing. In the suspended revolving type the motor is attached to a bearing within the lower hemisphere of the hollow suspension shell in such a way that the shaft makes an angle of 45 degrees with the horizontal and, of course, the same angle with the vertical axis of suspension. This brings the upper fan-blades further away from the axis of suspension than the lower blades at any instant. This, together with the fact that the backward pressure exerted by the fan tends to raise the motor, causes the whole motor to rotate about the axis of suspension due to the action of gravity acting in opposition to the repulsion of the blades which tends to raise the motor.

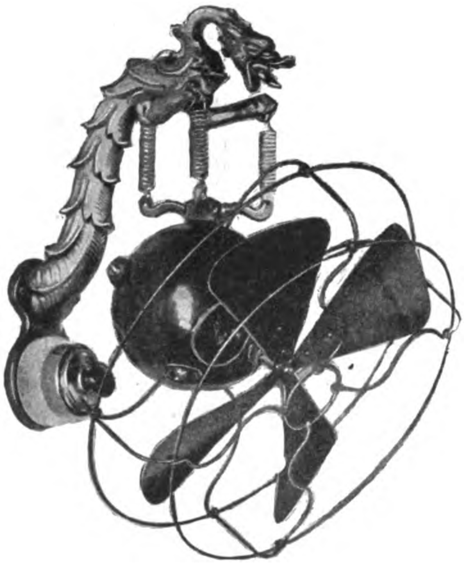


FIG. 20.—FT. WAYNE SUSPENDED MOTOR.

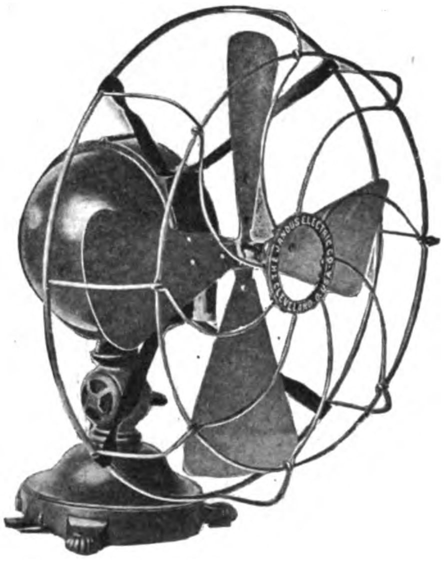


FIG. 21.—JANDUS DIRECT-CURRENT MOTOR.

The rate of rotation about the vertical axis varies, of course, with the speed of the fan and the angle of the blades. At a speed of 2200 r.p.m. the motor rotates about the vertical axis from 25 to 50 times per minute, depending upon the angle of the blades, which can be varied at will by bending them slightly.

The spherical case above the motor contains frictionless ball bearings on which the motor turns about the vertical axis. Current is delivered to the motor through brushes bearing on small collectors mounted on the upper end of the suspension bearing within the small spherical case, as shown in Fig. 19.

The fact that the motor is suspended while in operation necessitates making it as light as possible. This is accomplished by constructing the enclosing shell of the motor and the suspension sphere of aluminum alloy, which is amply strong enough for all strains and results in an exceedingly light motor. The revolving type is built for the same circuits and is attached to the lamp socket in the same manner as the attachment plug for the desk type motor. It may be suspended from any convenient electric light socket on a chandelier, wall bracket, etc.

The "Wood" fan-motors are also mounted as illustrated in Fig. 20. This type is intended for mounting directly on a wall or partition where silent running is essential. The motor is attached to a three-arm spider which replaces the suspension bearing used with the revolving type. This spider is suspended from three points of support through tempered spiral springs adjusted to take up all vibration of the fan. The special purpose for which this motor was designed was for use in telephone booths where noisy operation is prohibitive. It may be swung about a vertical axis and clamped in any position by a small set screw in the suspension spider. The wall bracket is hollow and encloses the wires leading from the motor to the switch in the base of the bracket. This motor can be used in series with a 16-c.p. 110-volt incandescent lamp on a 110-volt or 115-volt direct-current circuit. When so used the lamp and motor are connected to the line through a door switch arranged so as to light the lamp and start the motor when the cabinet door is closed. The speed of the motor is suitably lowered for use in this service and the candle-power of the lamp is also slightly reduced from its standard rate. For example, connecting the motor and lamp in series on a 110-volt direct-current circuit will result in a speed of 1100 r.p.m. by the motor and 12 candle-power is obtained from the lamp. The power used by the motor in this way is, of course, negligible, since the light is necessary anyway.

The Jandus Electric Company, Cleveland, Ohio, also builds a compact and graceful motor of the spherical type, as illustrated by Fig. 21. Fig. 22 shows the machine with the protecting caps removed, and Fig. 23 is a sectional view on a plane parallel with the shaft. The field magnet is bipolar and is built up of soft sheet steel stampings. The magnet coils are form wound, taped and varnished, and are connected in series with the armature, as usual in this class of machine. The armature is of the usual slotted type, but the coils are form wound and are insulated before being put in the slots. The brushes and brush-holders are of the cartridge type, but the brush cross-section is rectangular. The speed-regulating rheostat consists of resistance wire wound

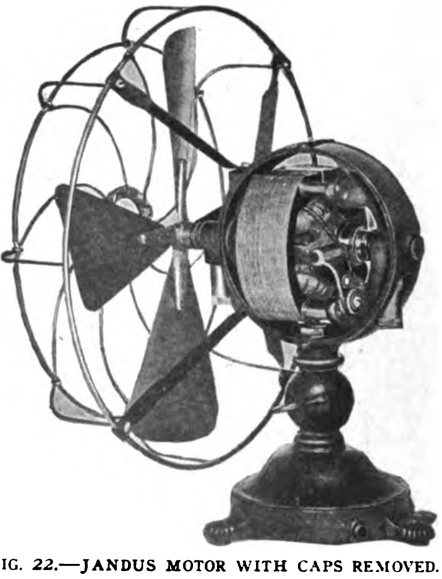


FIG. 22.—JANDUS MOTOR WITH CAPS REMOVED.

on an enameled tube and mounted in the pedestal base. The bearings are of the wick-oiling type, as shown in the sectional view, Fig. 23. These motors are wound for 100-120 and 200-250 volts, and have three speeds. The 12-inch fan runs at 900, 1200 and 1600 r.p.m. and takes 44 watts at maximum speed; the 15-inch fan runs at 900, 1150 and 1525 r.p.m. and requires 65 watts at full speed; the 16-inch fan runs at 800, 1050 and 1400 r.p.m. and takes 75 watts at full speed.

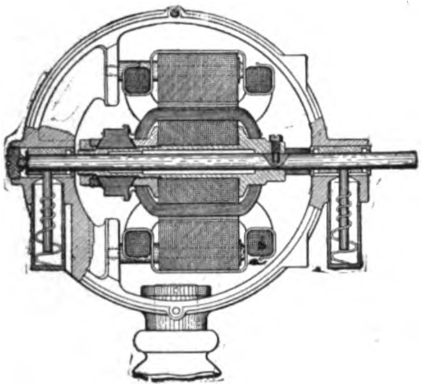


FIG. 23.—SECTION OF JANDUS MOTOR.

The Jandus Company also builds an alternating-current fan motor very similar in construction and appearance to the direct-current machine. It is built for 60 and 133 cycles and for 104 to 110 volts. Speed regulation is secured in this motor by means of a switch in the base which connects the field magnet coils in series or parallel, according to the speed desired. The fan diameters are the same as those of the direct-current machines. Both classes are provided with the swivel and trunnion mounting, shown in Fig. 24, which enables the user to change the motor pedestal from desk to bracket form by merely turning the base up through an angle of 90 degrees and screwing it to the wall or other vertical support.

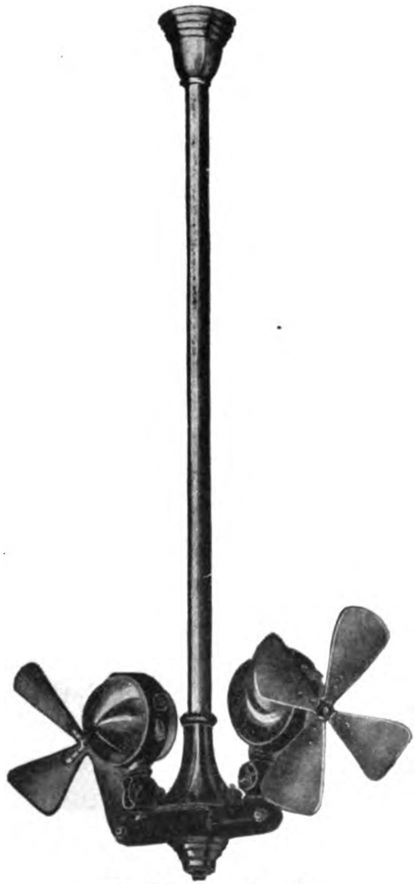


FIG. 25.—"GYROFAN."

Fig. 25 shows a method of mounting that the Jandus Company brought out last year. Two desk fans are seated on a bracket which is adapted to revolve about the axis of the hanger stem, and the motors are set at such an angle that the reactive effort of the fans causes the whole to revolve. The bracket may also be locked in any position and the fans adjusted to throw air continuously in any direction.

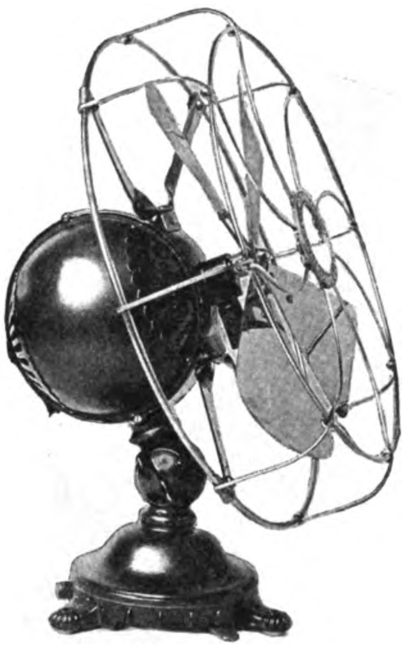


FIG. 24.—JANDUS ALTERNATING-CURRENT MOTOR.

This arrangement is designated the "Gyrofan"; it is also furnished with an ornamental electrolier beneath the revolving bracket when desired.

Another spherical fan motor is that built by the Colonial Electric Company, Ravenna, Ohio, and illustrated by Figs. 26 and 27, showing respectively the swivel and trunnion desk machine with a 12-inch fan, and the bracket mounting of the same machine in the 16-inch size. The Colonial motor is bipolar, with shell and magnet poles cast integral. The magnet coils are form-wound, taped, varnished and baked. The armature is slotted and drum wound. The slots are insulated with oiled linen and the coils are machine-wound directly into the slots. The machines are provided with the usual form of speed-regulating switch and rheostat mounted in the base. The normal running speed of the 12-inch fan is 1650 r.p.m., and the power required is 55 watts. The 16-inch fans run at 1350 r.p.m., with an input of 77 watts. The bearings are of phosphor bronze, self-aligning, and provided with wick-feed lubrication. These fans are also built with rigid mounting.

The Colonial ceiling fan motor is illustrated by Fig. 28, which shows the Type R machine. The brush-holders and brushes are of the cartridge and carbon-pencil type. The bearings are of phosphor bronze, self-oiling and self-aligning, and of such construction that the working parts are constantly immersed in oil. The sweep is 60 inches, and the speeds are 110 to 200 r.p.m. with four blades, or 130 and 220 r.p.m. with two blades; a two-blade switch being provided with each Type R fan. These machines are wound for 110, 170, 220, 250 and 500 volts, and the current required at these voltages is 1 ampere, 0.7 ampere, 0.55 ampere, 0.45 ampere and 0.23 ampere.

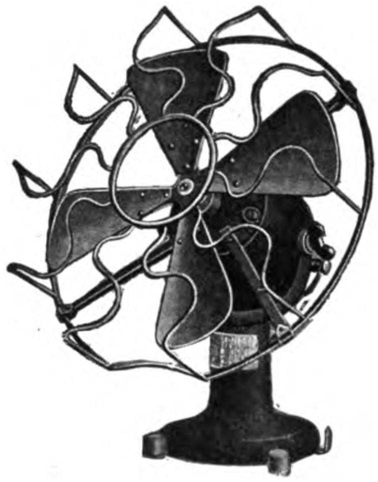


FIG. 26.—COLONIAL MOTOR.

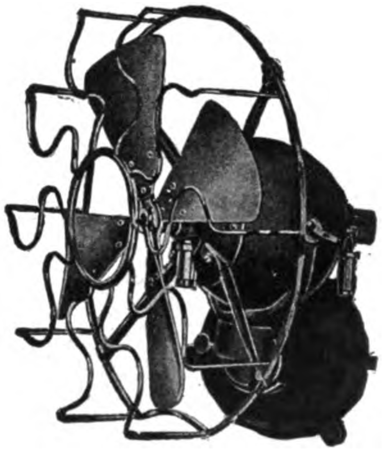


FIG. 27.—COLONIAL BRACKET MOTOR.

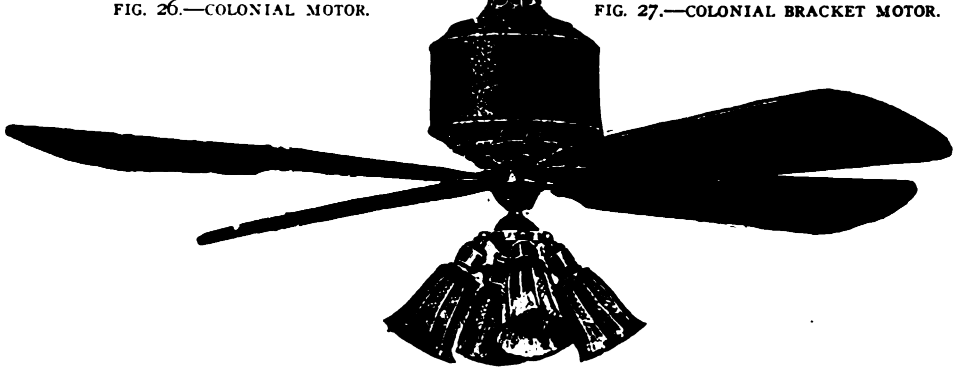


FIG. 28.—COLONIAL CEILING FAN MOTOR.

Fig. 29 illustrates the new Universal fan motor of the Eck Dynamo & Motor Works, Belleville, N. J., which was put on the market for the first time last summer and was brought out too late to be described in our fan-motor article last year. Like the three motors last described, this is of the globular bipolar type, but the internal construction is entirely different from the Wood and Jandus machines. The field-magnet is a one-piece casting of soft steel, and the coils are form-wound and hand insulated. The armature is of the usual slotted-drum machine-wound type. The field-magnet shell is provided with an oblong slot at the rear, through which the field coils are inserted and removed, this slot and the circular opening in the opposite side of the shell being closed by the journal brackets. As the engraving clearly shows, the fan is of the oscillating type. The oscillating device consists of a worm on an extension of the armature shaft, a worm-wheel mounted just beneath the rear journal, a crank disc, and a pitman extending from an adjustable crank-pin on the disc to a stationary pivot on the frame below the magnet shell. The shell is pivoted to the part of the frame just mentioned, and the revolution of the worm-wheel causes the entire motor to tilt forward and back on its pivot. The frame and shank on which the motor is mounted are supported on the pedestal by means of a ball and socket joint which permits the shank to be tilted at any angle with respect to the base. The motor therefore combines in a single structure both the universal adjustment on the pedestal and the oscillating feature. In order to convert it into a bracket machine, it is only necessary to turn the pedestal up through an angle of 90° and fasten the base against the wall instead of allowing it to set on a horizontal surface.

The brushes are rectangular carbon pencils held in a special form of holder which presses the brushes against the commutator in the same manner as the ordinary cartridge type of holder, but in addition, permits the removal of the brushes from the holders without dismantling the parts in any way. The bearings are lubricated by means of grease cups and automatic feeding pins. These machines are built for 115 and 230 volts, with 12-inch and 16-inch fan blades. The oscillating mechanism on the 16-inch fan motor is considerably heavier and stronger than that on the 12-inch machine, and even since the preparation of this data the Eck fans have been considerably improved in minor details, but the general features remain the same.

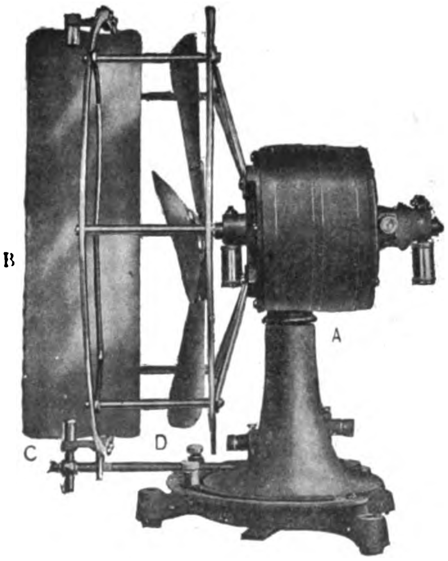


FIG. 30.—COMFORT OSCILLATING FAN MOTOR.

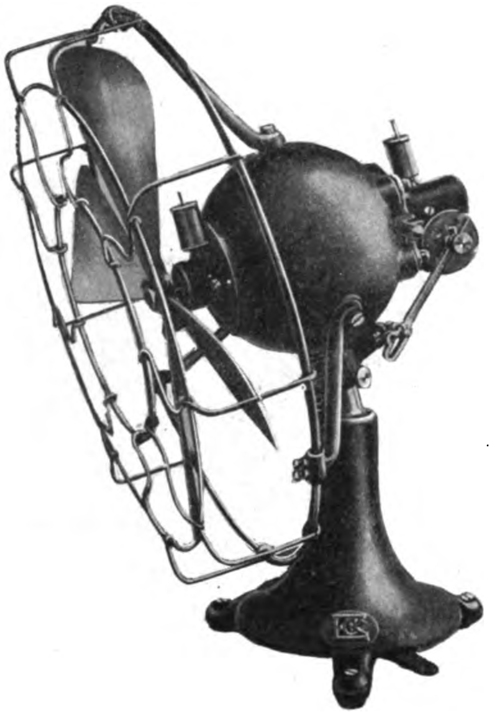


FIG. 29.—ECK UNIVERSAL FAN MOTOR.

The Eck Dynamo & Motor Works also builds a very compact exhaust fan outfit consisting of the standard fan motor mounted on a tripod and provided with a 16-inch fan, which is driven at 1600 r.p.m. Like the desk fan, this machine is wound for 115 and 230 volts. It requires 100 watts when running at rated speed.

The Comfort oscillating fan motor, shown by Fig. 30, turns about a vertical axis, instead of a horizontal one as in the previous case. The motor is of the bipolar type, with a one-piece field-magnet casting. The magnet coils are machine-wound and hand-insulated. The armature is of the usual slotted-drum type, but embodies the somewhat unusual feature in machines of this size of having the armature discs keyed to the shaft. The armature winding is of silk-covered wire heavily insulated from the core. The brushes and holders are of the familiar pencil and cartridge type and the brushes are of graphite. The bearings are self-aligning and oiled by means of wick-feed oil cups, as the engraving clearly indicates. The motor is mounted on a ball-bearing at the top of the pedestal, so that it is free to turn from side to side. Connections between the terminal posts at the base and the motor itself are made by means of small collector rings and brushes, in order to obviate the nuisance of flexible cords subjected to tortion stresses by twisting and untwisting as the motor oscillates. The oscillation is caused by the single vane, *B*, pivoted to the front of the fan-guard. A finger, *D*, is attached to the spindle at the lower end of the vane and projects over the base, on which two stops are mounted. When the motor swings in one direction this finger comes in contact with one of the stops and the vane is turned so that the reaction of the stream of air against it swings the motor back in the opposite direction until the finger comes in contact with the stop at that end of the travel. The stops are adjustable in a circular slot in the base so that the range of oscillation may be made anything up to 180°. The machine is built with either 12-inch or 16-inch fan blades and provided with a speed regulator which enables the motor to be operated at either 1400 or 1800 r.p.m. for the 12-inch size, and 1200 or 1500 r.p.m. for the 16-inch size. The power required by the 12-in fan is about 43 watts and the 16-inch fan requires about 90 watts at full speed. An unusual feature of detail construction is the rheostat conductor, which consists of a composition block about ½ inch square and 2¼ inches long. This is mounted flat on a porcelain base, and when included in the circuit with the fan, reduces the speed to the lower limits just stated. At full speed the resistance block is, of course, cut out. The machines are made by the Shedd Electric & Manufacturing Company, New York, and wound for the actual direct-current voltages. The fan-guard is made of brass and held together rigidly with screws.

The Emerson Electric Manufacturing Company has brought out this year a new line of alternating-current desk, bracket and ceiling fan motors known as the Trojan line. These machines are built to meet a demand for a slightly less expensive line than the standard Emerson machines. The difference between the two lines is confined chiefly to refinements. The Emerson standard fans have Parker fan blades, hardened steel shafts and a specially efficient self-starting winding. The Trojan machines have fan blades of the ordinary type, as indicated by Fig. 31 herewith, which shows the swivel and trunnion desk fan for 60 and 133 cycles. This machine is also self-starting, of course, and has two running speeds. The construction of the gearing is clearly shown by Fig. 32. The shaft is of

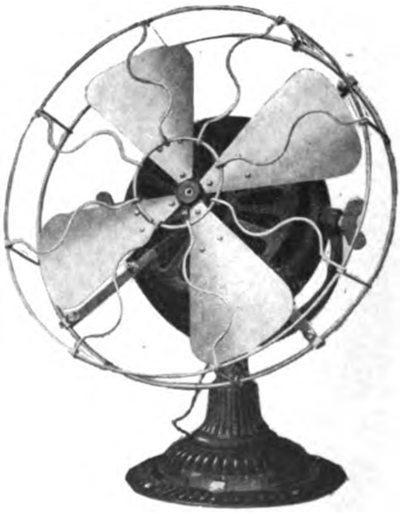


FIG. 31.—TROJAN ALTERNATING-CURRENT FAN MOTOR.

tool steel, ground to size, and revolves in the double bronze bearings shown in the engraving. Between the two bearings is a cavity which is filled with cotton wicking completely surrounding the shaft; oil is fed to the wicking from the oil cup in the cover hub, and felt washers at each end of the bearing prevent leakage of oil. The Trojan machines are built with 12-inch and 16-inch fans and for the usual alternating-current voltages. The 12-inch machine runs at 1600 r.p.m. at full speed and 1300 r.p.m. at slow speed, on either 60 or 133 cycles. The power required is 75 watts at full speed and 55 watts at slow speed. The 16-inch machine runs at the same speeds and requires 130 watts at full speed and 100 watts at slow speed. The machines are also built with bracket mounting, of course. Fig. 33 illustrates the Trojan ceiling fan motor, which is built only for 60-cycle current and one speed, namely, 225 r.p.m. The sweep of the blades is 52 inches and the motor requires 135 watts at full speed. This machine is also furnished with two blades of 56 inches sweep, and with this equipment requires 130 watts at full speed and runs at 225 r.p.m.

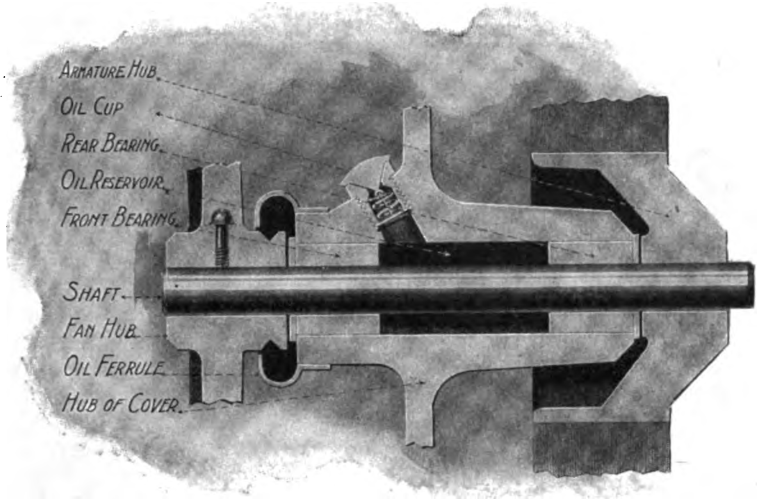


FIG 32.—SHAFT AND BEARING OF TROJAN MOTOR.

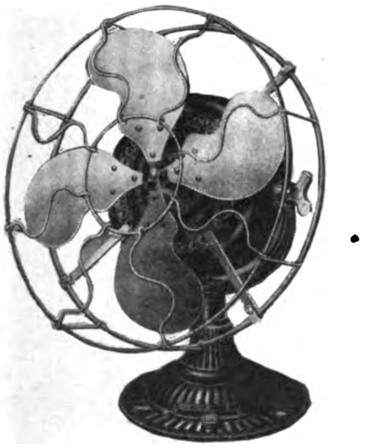


FIG. 34.—EMERSON 133-CYCLE MOTOR.

The Emerson standard line of fan motors is practically the same as last year. Fig. 34 shows the two-speed desk fan motor for 133-cycle circuits and with the swivel and trunnion mounting. The running speeds are 1400 r.p.m. and 1700 r.p.m., and the current consumption is 60 watts at the slow speed and 75 watts at full speed for the 12-inch size; 90 watts at slow speed, and 100 watts at full speed for the 15-inch size. These machines are wound for all of the standard alternating-current secondary voltages. This type of machine is also built in bracket form, as illustrated in Fig. 35, which shows the 60-cycle fan motor with this style of mounting, the only difference being the form of mounting. The 60-cycle motors are furnished with 12-inch and 16-inch fans, and require respectively 55 and 100 watts at full speed; the speeds are 1300 and 1650 r.p.m. for both sizes. Fig. 36 illustrates the field-magnet and rotor construction of the standard Emerson motor. The construction of the stator is similar to that of large induction motors, and it is provided with starting coils located midway between the regular working coils; these starting coils are cut out of circuit after the motor has attained normal speed. The rotor is of the ordinary squirrel-cage type.

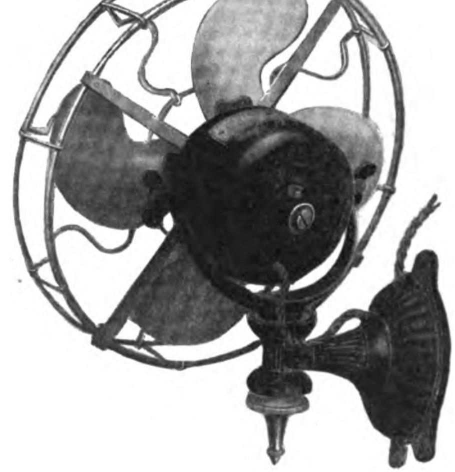


FIG. 35.—EMERSON 60-CYCLE BRACKET MOTOR.

Fig. 37 illustrates the method of lubricating the rotor bearings. There is no shaft, the rotor core being mounted on a drum provided with extensions, *F* and *F*, at each end, which fit around a stationary hollow spindle, *M*, and constitute bearings. The fan is provided with a hollow hub, *J*, screwed on the projection at one end of the rotor core-drum, so as to completely enclose the bearings at that end. The outer end of the bearing at the other end of the rotor is enclosed by a rawhide washer, *E*, mounted on a portion of the frame, *B*. Lubrication is provided through the oil cup, *A*, the lubricating oil being delivered to the interior of the hollow spindle, *M*, and finding its way through holes, *L* and *L*, to the bearings, *F* and *F*; the hollow fan hub, *J*, catches the oil at that end of the armature, and it is prevented from leaking out at the other end by the rawhide washer mentioned above. A cavity, *N*, within the armature spider, is provided for the retention of a reserve lubricant.

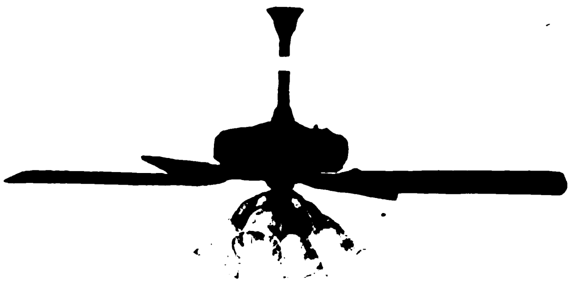


FIG. 33.—TROJAN CEILING MOTOR.

Fig. 38 illustrates the Emerson "residence type" of fan motor. It is similar in general construction to the machine just described, differing from it only in the speeds, which are 900 and 1100 r.p.m., and in the number of fan blades—6. The 12-inch fan-motor of this type requires 40 watts at slow speed and 50 watts at full speed; the 16-inch ma-

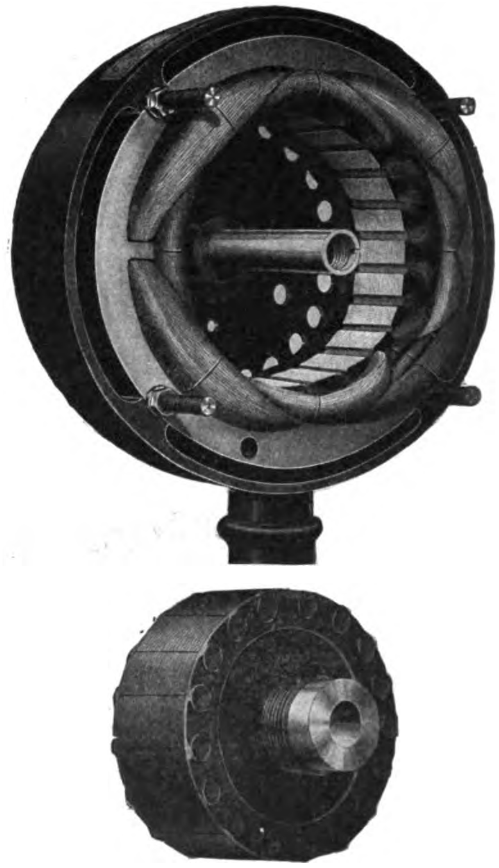


FIG. 36.—EMERSON FIELD MAGNET AND ROTOR.

chine requires 80 watts at slow speed and 90 watts at full speed.

The Emerson ceiling fan motor is a 60-cycle induction motor, somewhat similar in design to the desk type of machine. The stator has 28 poles, so that the full running speed is 225 r.p.m. There are two windings, disposed like the windings of a two-phase induction motor, and the windings are of different inductances so as to produce a rotating field at starting. Only 14 of the magnet poles are wound, and these are slotted up the center to take the extra "phasing" winding. Unlike the desk motors, this extra winding remains in circuit during the operation of the motor.

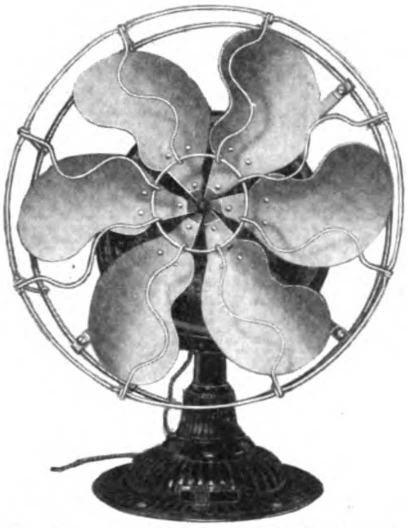


FIG. 38.—EMERSON "RESIDENCE" TYPE MOTOR.

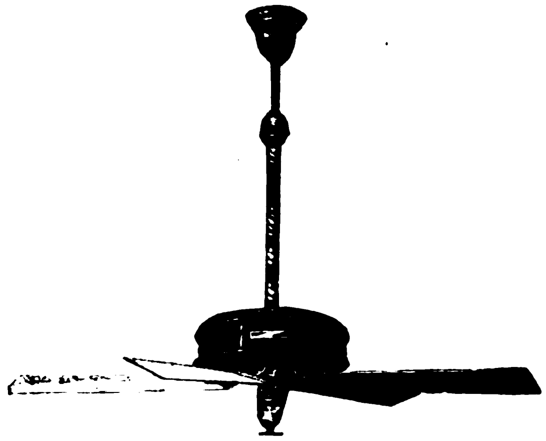


FIG. 39.—EMERSON 60-CYCLE CEILING MOTOR.

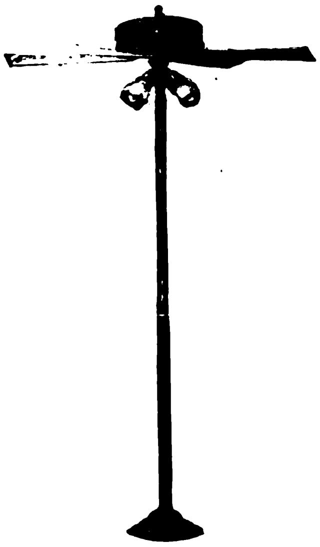


FIG. 41.—EMERSON COLUMN FAN MOTOR.

Fig. 40 illustrates the construction of the machines, from which it will be evident that the oiling arrangement peculiar to Emerson ceiling motors in past years has been retained. This consists of a spiral groove in the hollow armature shaft, which raises oil to the top of the shaft, whence it trickles down again and in doing so lubricates the bearing. Fig. 39 shows the exterior appearance of the four-blade fan, which has a sweep of 52 inches and requires 130 watts at full speed. It may be also operated at 180 r.p.m., when it requires 110 watts. These motors are also furnished with two blades of 56 inches sweep; the speeds are the same, and the power required is 125 watts at full speed and 100 watts at slow speed. The column fan, Fig. 41, is identical in construction with the ceiling fan-motor, except that only one speed (225 r.p.m.) is provided, and there is consequently no switch.

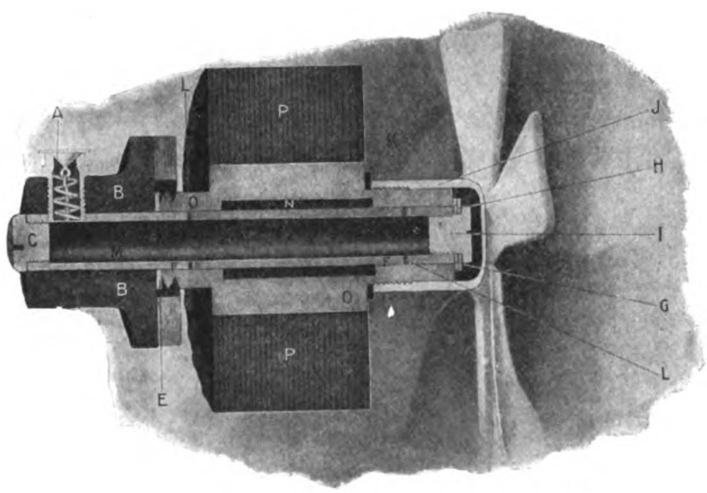


FIG. 37.—BEARING OF EMERSON DESK MOTOR.

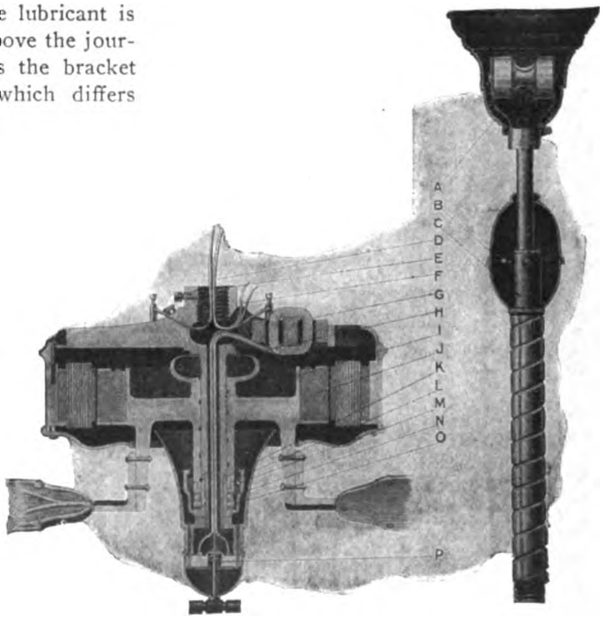


FIG. 40.—SECTION OF EMERSON CEILING MOTOR.

Fig. 42 illustrates the swivel and trunnion desk fan motor of the Pennsylvania Electric Company, Marietta, Pa. The motor is of the bipolar type and the field magnet is built up of soft sheet-steel laminations bolted to a cast-iron casing. The field-magnet coils are form-wound and hand-insulated. The armature is of the usual slotted-drum type, and the coils form-wound, insulated and baked before being put on the core. The commutator is unusually heavy for this style of machine and is insulated with the best grade of mica. The brushes are of rectangular cross-section and are set obliquely on the commutator, so as to prevent them from twisting and squeaking. The brush-holders are of the cartridge type, feeding the brushes to the commutator by means of helical springs. They are mounted in the rear cap of the frame and are removable without dismantling the motor. The bearings are self-aligning and the sleeves are turned up from solid phosphor-bronze stock. Grease is used for lubrication and the lubricant is contained in large chambers above the journal boxes. Fig. 43 illustrates the bracket mounting of this machine, which differs from the desk type only in the form of swivel employed. The machines are supplied with 12-inch and 16-inch fans and are wound for 110, 220 and 500 volts. The 500-volt motors have only one running speed, but the others have three. The 12-inch fan may be operated at 1800, 1500 or 1100 r.p.m. and requires 55 watts at full speed. The 16-inch fan runs at 1650, 1200 or 900 r.p.m. and requires 75 watts at full speed. These machines are also built with solid frames for desk service. With exception of swivel and trunnion mounting, the specifications are exactly the same as for the machines just described.

The ceiling fan motors of the Pennsylvania Electric Company are furnished with electroliers or without them; in the latter case the appearance of the fan is as shown in Fig. 44. The motor is bipolar, with a single-piece cast-iron field magnet, and the armature is of the slotted-drum type. Both the field magnet and armature coils are form-wound, hand-insulated and baked. The commuator is of the usual barrel type with heavy segments and first-grade mica insulation throughout. The brush-holders and brushes are of the same type as those on the desk and bracket fans. The armature revolves on a single long bearing, which is constantly flooded with oil from a chamber at the bottom of the fan, which holds a supply sufficient for a complete season's run. The standard ceiling fan motors have only one running speed, namely, 225 r.p.m., and require 97 watts. They are also supplied, however, with speed regulators, giving two or three speeds when desired. The three-speed fans run at 225, 185 and 140 r.p.m., and the two-speed fans at 225 and 175 r.p.m. The blades are of polished hardwood, 7 inches wide at the tips and with a sweep of 60 inches. Four blades are usually supplied.

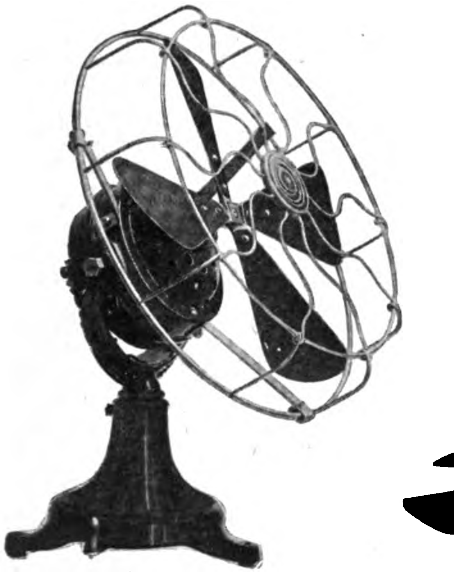


FIG. 42.—PENNSYLVANIA DESK MOTOR.

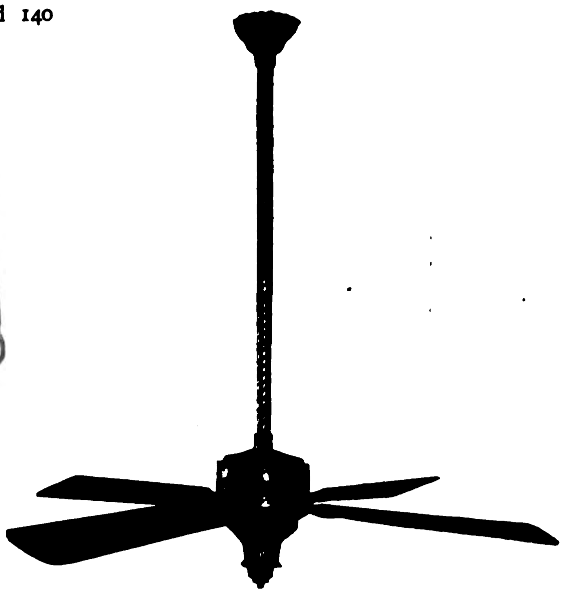


FIG. 44.—PENNSYLVANIA CEILING MOTOR.

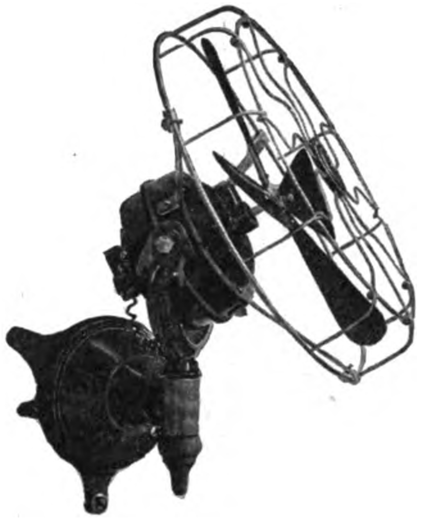


FIG. 43.—PENNSYLVANIA BRACKET MOTOR.

The Pennsylvania Company states that arrangements have been made with the owners of such patents as cover fundamental features of ceiling fans, so that the users of their apparatus are immune from interference on this score. Every machine sent out is first tested thoroughly.

The Paragon fan motors, built by the General Incandescent Arc Light Company, New York, remain fundamentally unchanged; the machines have been improved in minor details, but the general design is the same. The field-magnet is a single-piece casting of soft iron, with the front journal box integral; the rear bearing is contained in a removable cap, as indicated by Fig. 46, the removal of which leaves an aperture large enough to withdraw the armature and field coils. The field-magnet coils are machine-wound, covered with two layers of linen tape, dipped in insulating varnish and thoroughly baked. The armature is of the slotted-drum type, hand-wound; the complete armature is dipped and baked. As shown by Fig. 46, the brush-holders are mounted in the removable journal cap; the brushes are rectangular carbons fed by helical springs in the usual manner. The bearings are self-aligning, have phosphor-bronze sleeves, and are lubricated by under-fed wick oilers in the standard machine. The company also builds what is known as the "Paragon Black" fan motor, which differs from the standard machine only in point of finish and in the use of grease instead of oil cups for lubrication. The standard motor is finished in dark green enamel with gilt stripes and the brass work is polished and lacquered, while the "Black" motor is finished in plain black enamel, with dipped and lacquered brass work and an enameled iron fan guard instead of the polished brass guard used on the standard Paragon motor.

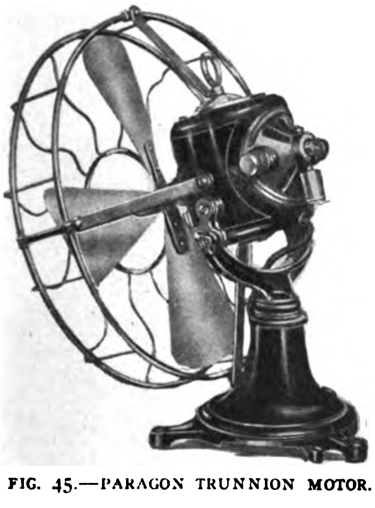


FIG. 45.—PARAGON TRUNNION MOTOR.

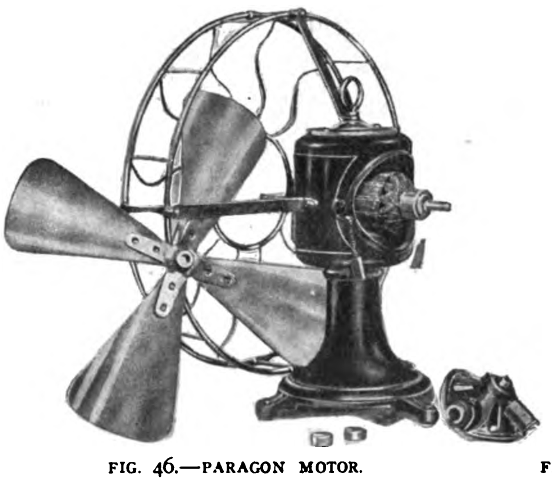


FIG. 46.—PARAGON MOTOR.

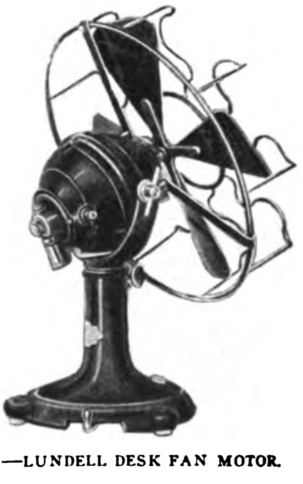


FIG. 47.—LUNDELL DESK FAN MOTOR.

Fig. 45 illustrates the Paragon swivel and trunnion form of mounting, from which it will be seen that the trunnion adjustment is limited by a stud projecting through a slot in the trunnion arm and the motor is held in position by a thumb nut on this stud. The machines are also built with bracket form of mounting. All of them are built with 12-inch and 16-inch fans and wound for the usual direct-current voltages up to 250 volts. They are provided with enamel insulated resistances and regulating switches which give three running speeds, the resistance being mounted within the pedestal. The 12-inch machines run at 1700 r.m.p. and require from 35 to 45 watts, according to the voltage; the 16-inch fan motors run at 1500 r.p.m. and require from 60 to 70 watts, according to voltage. This data applies to both the standard and the Black Paragon fans.

The Lundell fan motors built by the Sprague Electric Company, New York, are illustrated by Figs. 47 and 48. These machines are of the well-known concentric field coil type which has been employed in small Lundell motors for many years past. They are equipped with form-wound hand-taped field windings which are varnished and baked; the armature is of the usual slotted-drum type. The brushes and brush-holders are of the pencil and cartridge type and the oil cups are the under-feed wick type originated by Mr. Lundell several years ago. The machines are built this year only in 12-inch and 16-inch sizes, the 15-inch and 18-inch sizes having been discontinued. They are provided with either rigid mounting or the swivel and trunnion mountings here illustrated and are equipped with three-speeds rheostats and switches. The 12-inch fans run at 800, 1350 and 1900 r.p.m. and require from 52 to 57 watts at full speed, according to the voltage; the 16-inch fans run at 800, 1150 and 1450 r.p.m. and require 103 watts at full speed regardless of voltage.

The Diehl Manufacturing Company, Elizabethport, N. J., has brought out an entirely new line of direct-current desk and bracket fan motors this year. Fig. 49 illustrates the 12-inch desk fan motor. The field-magnet is a single-piece casting with two poles and the ends are closed by the journal caps. The field-magnet coils are form-wound of silk-covered wire, heavily taped, dipped and baked before going on the machine. The armature is of the usual slotted drum-wound type; the winding is of double silk-covered wire and is wound directly into the insulated slots by machine. The commutator is built up of hard-drawn copper bars and insulated throughout with mica. The brushes and brush-holders are of the pencil and cartridge type, but the brushes have rectangular cross-sections. The brush-holder caps are of fibre and are held in place by a pin which is readily withdrawn, the use of screw threads being avoided on account of the liability to damage the cap in removing or replacing it hastily. The machines are all equipped with three-speed rheostats consisting of high-resistance wire wound on a mica plate. The fan guard is also new this year. The outer ring of the guard is made of square stock, and the braces which hold it to the fan body are made of similar stock; the outer ends of these braces are bent so as to hug tightly the outer ring and one of the curved arms, as may be seen by close inspection of Fig. 50, thus rendering solder and screws unnecessary. The bearings are of the usual type, lubricated by means of under-feed wick oilers. The mounting is of the trunnion and swivel form and the trunnion is attached to the pedestal by a ball and socket joint so that the desk fan motor may be converted into a bracket fan motor by loosening a small screw in the head of the pedestal, swinging the latter up through an angle of 90 degrees and resetting the screw in place. See Fig. 50. The motors equipped with 12-inch fans are wound for 110 and 220 volts and require 36 watts at full speed; the speeds are 1750, 1400 and 1100 r.p.m. The motors having 16-inch fans are wound for all three direct-current voltages and require 80 watts at full speed; the speeds are 1450, 1100 and 800 r.p.m.

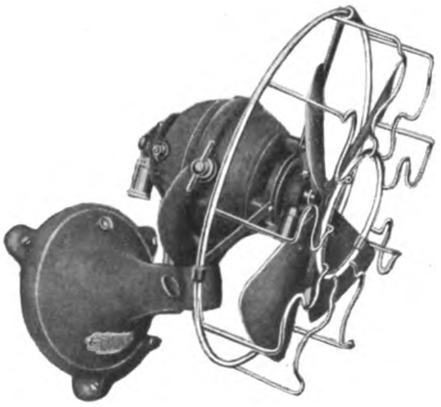


FIG. 48.—LUNDELL BRACKET MOTOR.

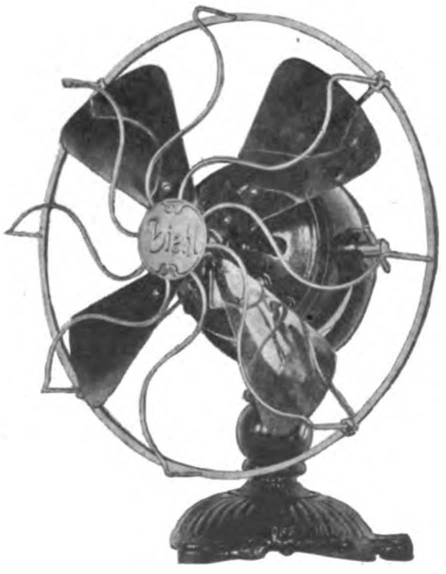


FIG. 49.—DIEHL DESK MOTOR.

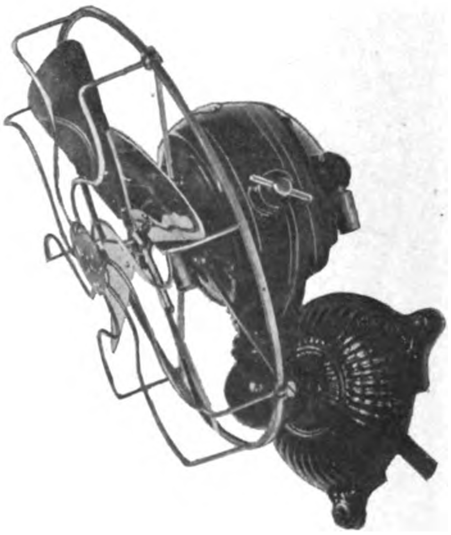


FIG. 50.—DIEHL BRACKET MOTOR.

The Diehl ceiling fan motors remain practically unchanged, so far as constructional features are concerned. The insulation of the machines has been considerably improved, however, the windings being subjected to extra dipping and baking as compared with the previous practice. Fig. 51 illustrates the standard machine, the motor of which is bipolar with a laminated internal field magnet, the armature being of the Gramme-ring external type. As the engraving shows, a part of the case is attached directly to the armature and revolves with it, and the blades are mounted in sockets on this part of the casing. The Diehl internal drum armature ceiling fan motor is illustrated by Fig. 52. The field-magnet is of cast iron in a single piece and is equipped with machine-wound coils which are heavily taped, dipped and baked before being put in place. The armature is of the slotted drum type; in fact, the whole design of the machine is somewhat similar to that of the desk motor. The coil slots in the armature core are insulated with micanite troughs and the coils are machine-wound directly into the slots.

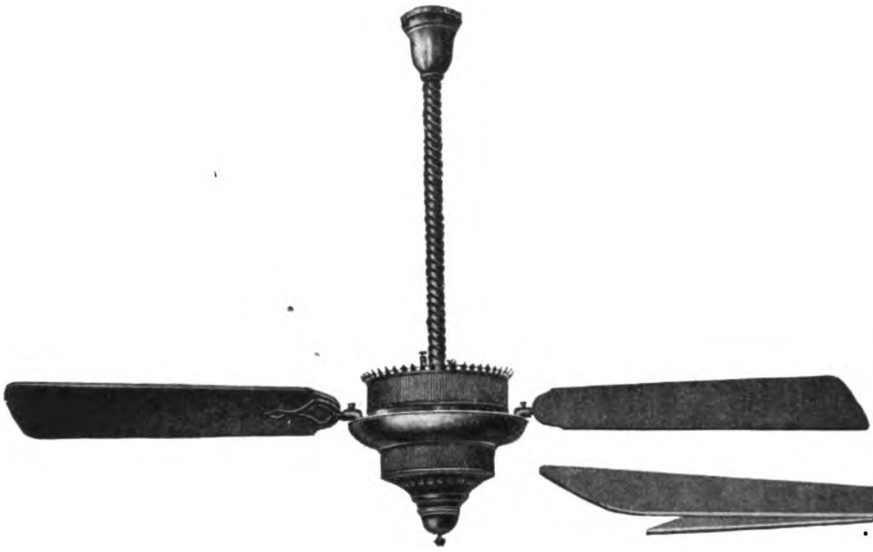


FIG. 51.—STANDARD DIEHL CEILING MOTOR.

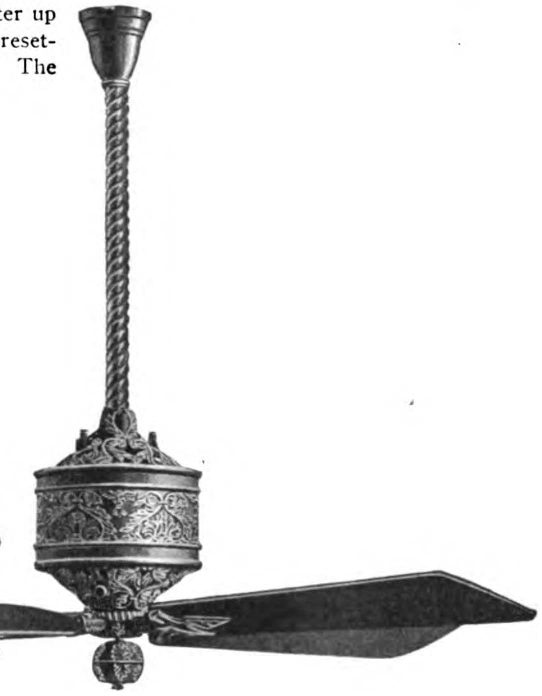


FIG. 52.—DIEHL INTERNAL-DRUM-ARMATURE CEILING MOTOR.

Fig. 53 illustrates the direct-current bracket fan motor of The Peerless Electric Company, Warren, Ohio. The desk machine is exactly similar except in the manner of attaching the swivel to the pedestal. The motor is bipolar, with the yoke-ring and magnet poles cast integral, and has the usual slotted-drum type of armature. The field-magnet coils are heavily insulated and taped; cotton-covered wire is used for low voltages and silk-covered wire for high-voltage machines. This is also true of the armature windings, and the winding is insulated from the armature core by oiled linen; after being connected to the commutator it is tested for break-down between the individual coils and between the coils and the core, 500 volts being applied to the 110 and 220-volt armatures and 1000 volts to the 250 and 500-volt armatures. The brushes are of the carbon pencil type, fed in cartridge brush-holders by helical springs. The commutator is built up of hard-drawn Lake Superior copper, machined to size and insulated with the best grade of mica. Mica is also used to insulate the ends of the segments from the clamping rings. The bearings are lubricated by under-feed wick oilers; the manufacturers recommend the use of heavy cylinder oil in the reservoirs. The bearings are self-aligning with sleeves of gun metal. The fans are provided with three-speed rheostats consisting of a German silver conductor wound on a porcelain spool and the usual form of swivel switch mounted on a porcelain plate in the base of the pedestal.

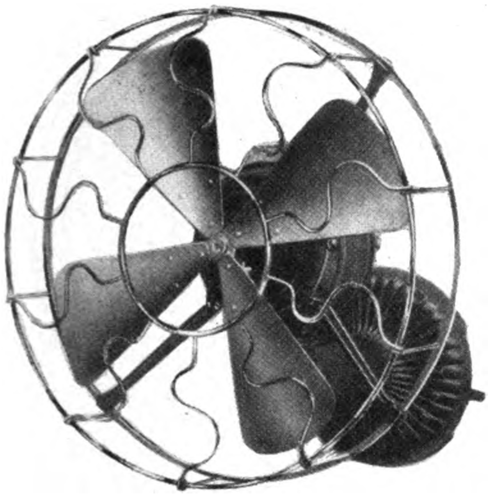


FIG. 53.—PEERLESS DIRECT-CURRENT BRACKET MOTOR.

The Peerless alternating-current desk fan motor is illustrated by Fig. 54. This is a simple single-phase induction machine and is provided with an ingenious starting switch which is so constructed that it gives the rotor a strong impetus when the switch handle is thrown to connect the machine to the circuit. The rotor is of the squirrel-cage pattern, with a shaft of drawn steel. The bearing of the shaft is long and is composed of a seamless drawn tube of phosphor bronze forced into position in the fan motor case, being reamed to accurate size after it is placed in position in order to avoid the liability of a poor fit on the motor shaft. The base of the starting device and switch is made of vulcanized rubber, and the contact blades and points are of phosphor bronze. The mounting is of the swivel and trunnion type. The motors are made with three speeds and are of two sizes: 12-inch and 16-inch, wound for any voltage and frequency up to 250 volts and 140 cycles.

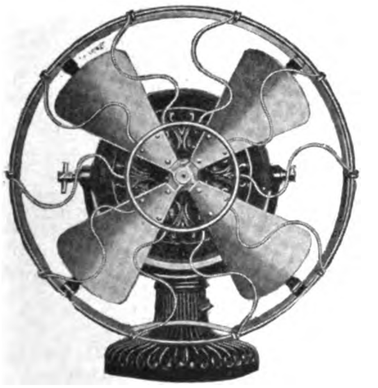


FIG. 54.—PEERLESS ALTERNATING-CURRENT DESK FAN-MOTOR.

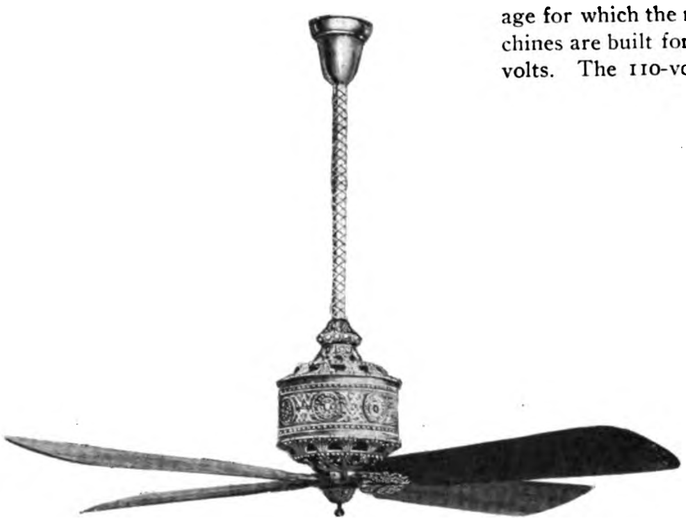


FIG. 55.—PEERLESS CEILING FAN MOTOR.

Fig. 55 illustrates the Peerless Type H-1 ceiling fan motor, which is built for all of the standard direct-current voltages. Fig. 56 is a vertical sectional view of the motor. The machine is bipolar, with form-wound field-magnet and armature coils. The insulation and other features are the same as in the direct-current desk fan motor, except the arrangement of the bearings and the method of lubrication. The bearings are submerged in two oil baths, as the illustration clearly shows; the sleeves are of gun metal and self-aligning. The cartridge-type brush-holders are mounted in the lower part of the casing so as to be accessible without disturbing the casing. The machine is furnished with either four blades, as shown in the illustration, or two, the sweep being 60 inches in both cases. The full speed with four blades is 200 r.p.m. and 220 r.p.m. with two blades. The power required ranges from 110 to 115 watts, according to the voltage for which the motor is wound. The machines are built for 110, 170, 220, 250 and 500 volts. The 110-volt and 220-volt machines are provided with two-speed switches, as shown in Fig. 56, the switch being located at the top of the frame work and operated by means of a spindle through the hollow armature shaft and terminating in a button at the bottom; the slow speed is 110 r.p.m. for the four-blade fans and 130 r.p.m. for the two-blade machines. The motors for the other three voltages specified operate at one speed only.

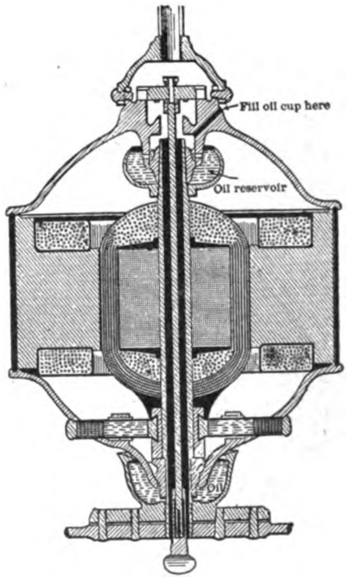


FIG. 56.—SECTIONAL ELEVATION OF PEERLESS CEILING FAN MOTOR.

The Eclipse fan motors, illustrated by Figs. 57 to 64, are built by the Fidelity Electric Company, Lancaster, Pa., successor to the Geo. C. Towle Mfg. Company. The construction of the field magnet is clearly indicated by Fig. 58. The field-magnet coils are form-wound to a rectangular outline and drawn into the slots on each side of the polar extensions after being insulated by hand, varnished and baked. The armature is of the familiar slotted-drum type, with the coils wound directly into the slots. The illustration shows rigid pedestal mounting, but the machines are also built with swivel and trunnion mounting, as shown by Fig. 61, which represents the bracket form of motor. They are built in 12-inch and 16-inch sizes, and furnished with three-speed rheostats and switches. The 12-inch fan runs at 1000, 1600 or 2000 r.p.m., and the

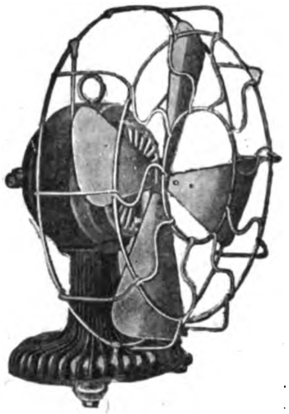


FIG. 57.—ECLIPSE MOTOR.

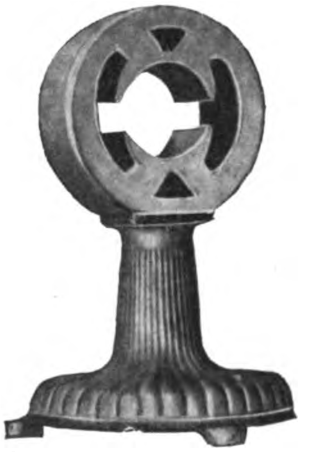


FIG. 58.—ECLIPSE FIELD-MAGNET FRAME.

16-inch fan at 600, 1000 or 1650 r.p.m. Fig. 60 shows the duplex fan motor of this company, consisting of a rigidly-mounted desk machine with two fans and guards. These are wound for 110, 170, 220 and 250 volts, and are furnished with rheostats and switches giving 1000, 1400 and 1800 r.p.m. This form of machine is also built with the standard type of motor used in the desk fan motor described above.

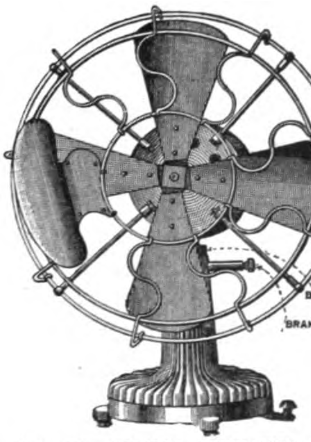

BALL BEARING.
BRAKE SCREW.

FIG. 59.—ECLIPSE REVOLVING MOTOR.

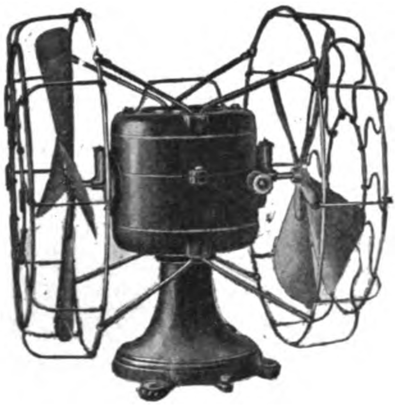


FIG. 60.—ECLIPSE DUPLEX MOTOR.

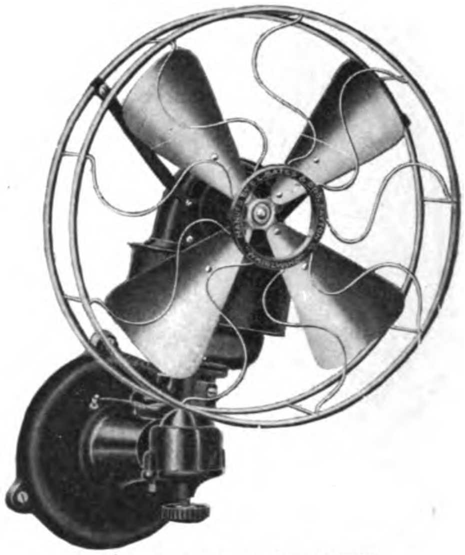


FIG. 65.—BATES BRACKET MOTOR.

Fig. 59 shows the revolving desk fan motor of the Fidelity Company, brought out last year. The motor is mounted on a ball-bearing at the top of the pedestal and is caused to revolve about its vertical axis by the reaction of the air blast on the deflector shown attached to the fan guard. Connections are made between the motor and the terminals on the base by means of small collector rings mounted on the shank of the motor frame and brushes mounted on a porcelain plate in the pedestal base. The fan is provided with a two-speed rheostat and switch in the pedestal base. The rate at which the motor revolves about its vertical axis is adjustable by means of the brake screw shown at the top of the pedestal in the illustration. The Fidelity ceiling fan motor is of essentially the same design as the motor of the desk and bracket machine, except that the motor has four field-magnet poles and the armature coils are form-wound and insulated before being put on the core. These machines are furnished without the electrolier shown in Fig. 62 unless it is specially ordered. Either two or four blades are furnished, and the speed is 180 to 200 r.p.m. The motors are wound for the standard direct-current voltages and also for 170 volts to operate three in series on a 500-volt circuit.

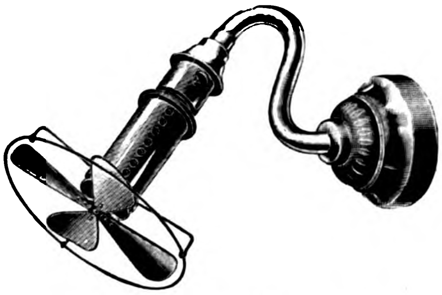


FIG. 63.—ECLIPSE SOCKET MOTOR.

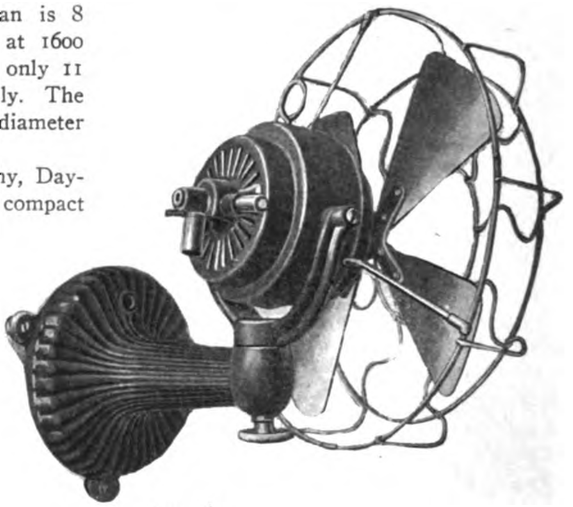


FIG. 61.—ECLIPSE BRACKET MOTOR.

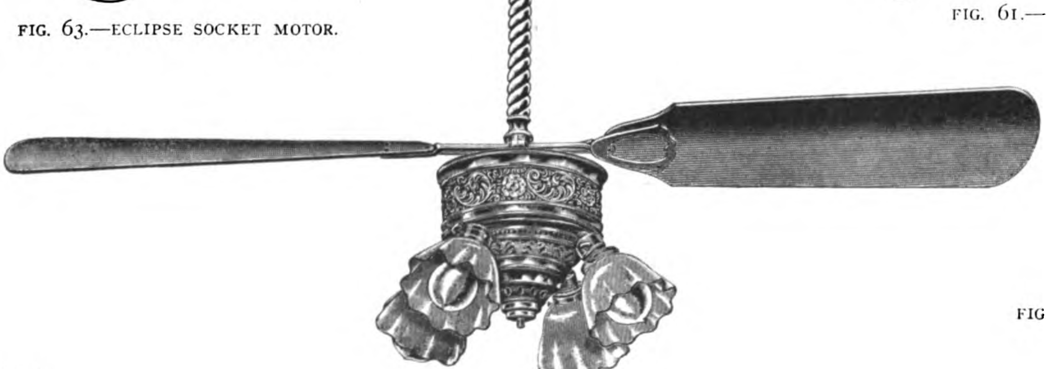


FIG. 62.—ECLIPSE CEILING MOTOR.

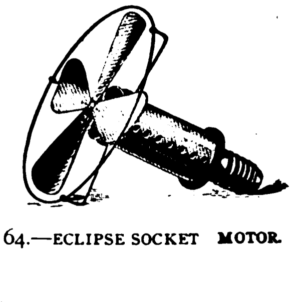


FIG. 64.—ECLIPSE SOCKET MOTOR.

Fig. 64 shows an ingenious little socket fan motor brought out this year by the Fidelity Company, and Fig. 63 shows the motor in position for operation. The field-magnet is bipolar, with a single coil, and the motor is completely enclosed in a ventilated brass casing, which terminates at the rear end in a screw plug to fit the standard Edison lamp socket. The fan is 8 inches in diameter and is driven at 1600 r.p.m. with an electrical intake of only 11 watts; it is wound for 110 volts only. The motor casing is only 1¾ inches in diameter and 4½ inches long over all.

The D. L. Bates & Bro. Company, Dayton, Ohio, continues to build the compact type of bipolar fan motor illustrated by Figs. 65 and 66. The magnet cores are of forged steel, and the armature is of the usual slotted-drum type. The armature is protected by enclosing caps applied to the magnet poles and containing the journal boxes. These machines are built for 110, 220 and 500-volt circuits. The bracket motor (Fig. 65) is provided with a universal socket adjustment and the desk motors are built with either a swivel and trunnion base shown in Fig. 66, or a solid base. The power consumption of the machines at full speeds is as follows: 12-inch fan at 110 volts, 31 watts; at 220 volts, 44 watts; 16-inch fan at 110 volts, 60 watts; 220 volts, 83 watts, and at 500 volts, 125 watts. All of the fans are provided with three-speed switches, giving speeds of 1500, 1700 and 1900 r.p.m. in the 12-inch size; 1200, 1350 and 1600 r.p.m. in the 16-inch 110-volt machine; 1400, 1500 and 1600 in the 16-inch 220-volt machine, and 1300, 1400 and 1500 in the 16-inch 500-volt machine.

The Bates "Style E" ceiling fan motor with electrolier attachment is illustrated by Fig. 67; the construction of the motor itself is shown by the sectional elevation, Fig. 68. The machine has a six-pole field magnet with the yoke-ring and poles cast integral. The magnet coils are wound on fibre spools and heavily insulated. The armature core is a slotted-drum of large diameter and the coils are form-wound and hand insulated before being put in place. The commutator bars are of hard-drawn copper and are assembled under hydraulic pressure. The brush-holders and brushes are of the cartridge and pencil type, with helical springs for feeding the brushes. The holders project through openings in the lower part of the motor casing, so that the brushes may be renewed without disturbing any other part of the machine. The brushes are of rectangular cross-section, ¼ x ⅜ inch in size. The motors are furnished with or without the switch shown in the sectional view; the switch proper is indicated by *S* and the speed-regulating rheostat by *R*. The machine is also supplied with the switch alone for convenience in starting and stopping the fan. When furnished with four blades the sweep is 54 inches; two blades of 59 inches sweep are supplied when desired. These machines are wound for 110, 167, 220, 250 and 500 volts. The 110-volt machine requires 85 watts at full speed.

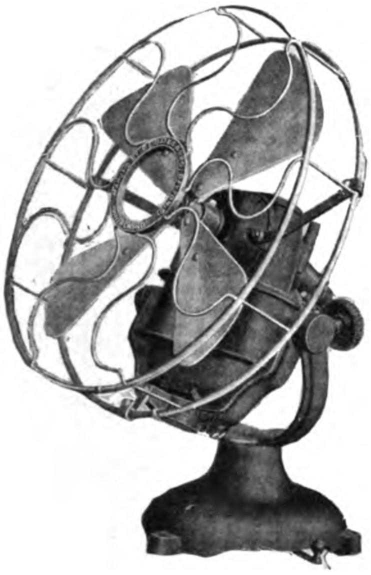


FIG. 66.—BATES DESK MOTOR.

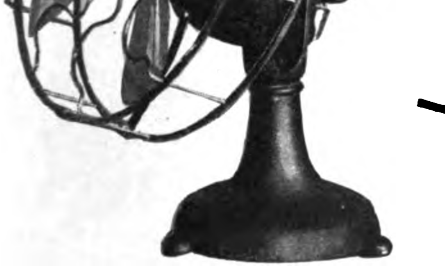


FIG. 69.—DAYTON DESK MOTOR.

Fig. 69 illustrates the direct-current desk fan motor built by the Dayton Fan & Motor Company, Dayton, Ohio. This machine is bipolar and equipped with the usual form of slot-wound drum armature, cartridge and pencil brush-holders and brushes, under-feed self-oiling bearings, and three-speed rheostat. The motor is built in three styles of mounting: the swivel and trunnion pedestal mounting, shown in the engraving, the same style of mounting in bracket form, and a rigid pedestal mounting. The motor is wound for 110, 220 or 500 volts. The speeds are 1800, 1300 and 800 r.p.m., and the power consumption for the 12-inch fan is 44 watts at full speed. The construction is very similar to that of the Dayton Junior ceiling fan motor illustrated by Fig. 72, so far as the field-magnet and armature are concerned; the bearings are of course different, being of the usual type for horizontal shafts. In the Dayton Junior ceiling fan motor the usual form of armature shaft is employed. The case is stationary, being mounted solidly on the field-magnet frame. The lower bearing is lubricated from the reservoir in that part of the casing marked *B*. Fig. 72, the oil being caught in the cup formed in the upper part of the fan-blade hub; the upper bearing is oiled from the reservoir, *J*, the oil that trickles through being caught in the cup, *I*, mounted on the armature shaft. The commutator of this machine is of the usual type, and the brush-holders of the cartridge type, provided with adjusting screws. The Dayton Junior fan is usually provided with four blades, and runs at 225 r.p.m.

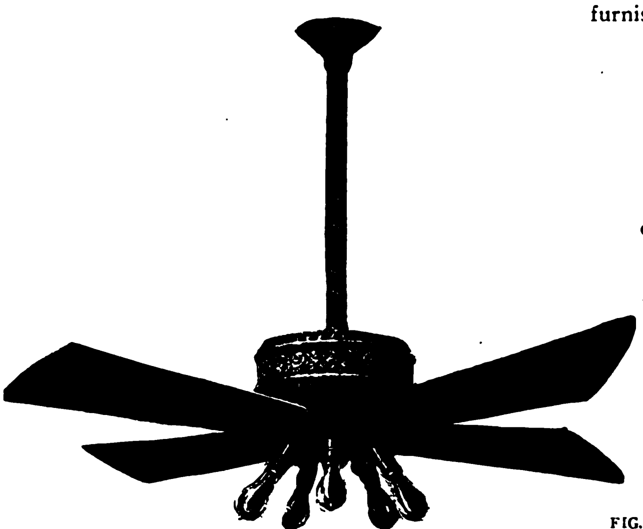


FIG. 67.—BATES CEILING FAN MOTOR.

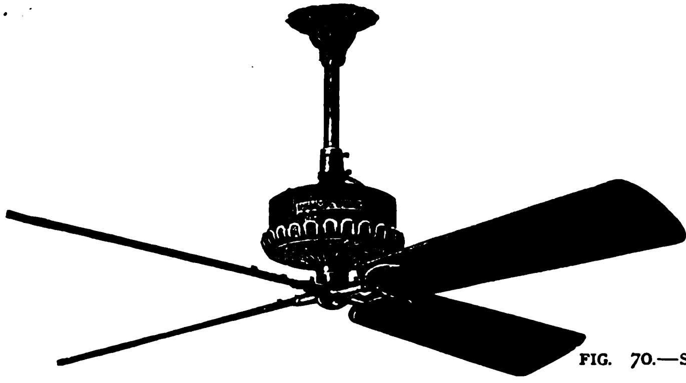


FIG. 71.—DAYTON CEILING FAN.

Fig. 71 illustrates the Dayton Fan & Motor Company's standard ceiling fan motor, this engraving showing the style that is furnished for operation at 500 volts; Fig. 70 is a cross-section through the motor of this machine. It will be evident from an inspection of the latter engraving that the field magnet is bipolar and has channeled pole-pieces which embrace three sides of the armature cross-section. The armature winding is necessarily of the Gramme ring type, and the arrangement of the air-gap obviously results in a very low magnetic reluctance in this part of the circuit. The field-magnet coil is divided into two sections, in order to leave the center of the core free for the passage of the axle about which the armature rotates. The armature is secured by means of the screws directly to the ornamental casing, *B*, which closes the motor in on the under side, and this casing also carries the commutator, *C*, which is of the disc type. The casing, *A*,

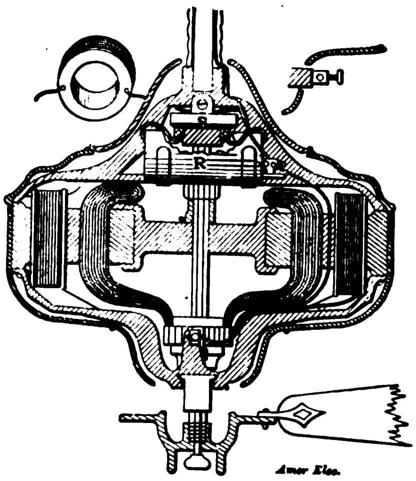


FIG. 68.—SECTIONAL ELEVATION OF BATES CEILING MOTOR.

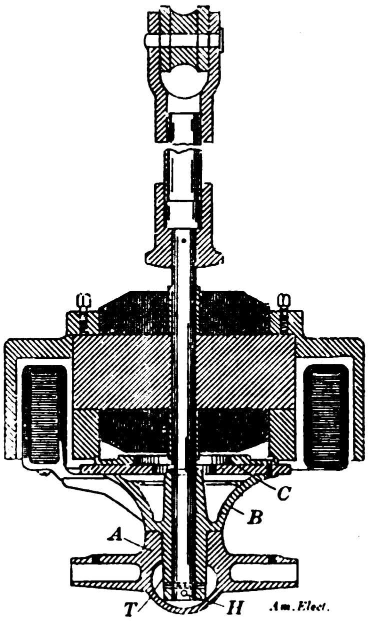
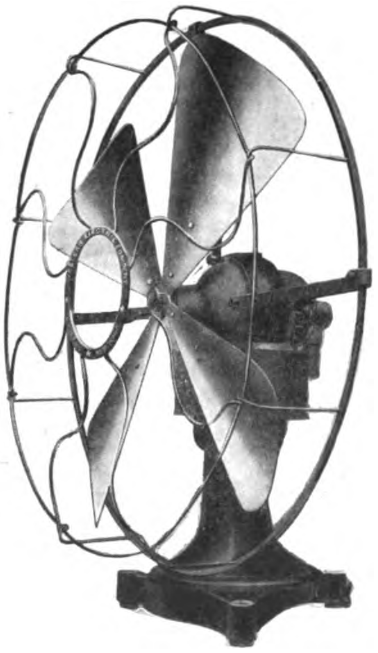


FIG. 70.—SECTIONAL ELEVATION OF DAYTON CEILING FAN MOTOR.

with which the fan-blade sockets are integral, is screwed onto a hub at the bottom of the casing, and contains a large cup for the retention of the oil that trickles through the bearing. Oil is supplied to this bearing from the reservoir located immediately beneath the commutator.

There is, properly speaking, no armature shaft, the casing, *B*, revolving about the stationary axle, *H*, which is held in the socket by means of set screws. The Dayton standard fan is supplied ordinarily with four blades for all circuits except 500 volts, and runs at 215 r.p.m. The 500-volt fan is provided with two blades and runs at 210 r.p.m.

The general appearance of the Western Electric Company's desk fan motor for 1904 is similar to that of the well-known type of the past year. Fig. 73 is an external view and Fig. 74 is a cross-sectional view of the machine. The field-magnet is of the inverted horseshoe type, which style of construction allows a short pedestal and small enclosing castings to be used, thereby making the weight of the motor unusually low, as a large proportion of the weight is in the "working material." The weight of the motor is further reduced by the use of a forged steel field magnet. The armature is of the slotted drum type, wound with double silk-covered wire, which is insulated from the core by pressboard tubes in the slots and pressboard discs over the end plates. The field-magnet coils are wound on pressboard spools, and being exposed to the direct action of the moving air, an exceptionally low-running temperature is obtained. The large diameter of the armature, the forged steel field magnet, field coils of small diameter cooled by moving air, a short air-gap and careful shaping of pole tips, all affect the efficiency of the motor favorably.



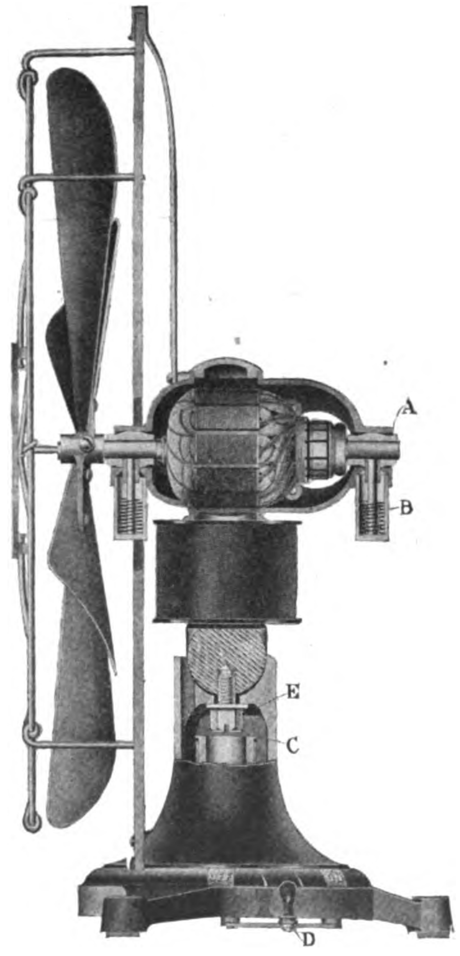


FIG. 73.—WESTERN ELECTRIC DESK FAN MOTOR.—FIG. 74.

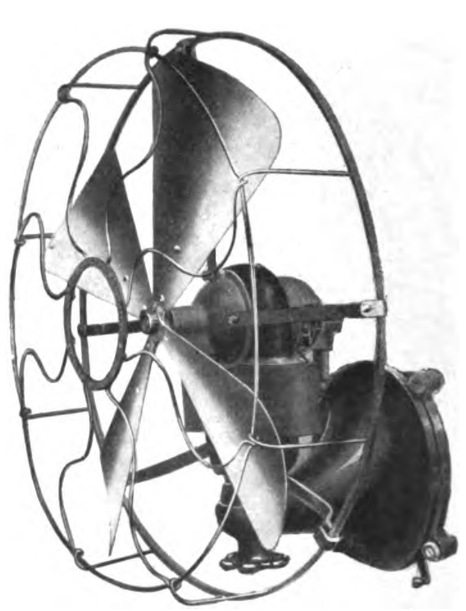


FIG. 75.—WESTERN ELECTRIC BRACKET MOTOR.

The commutator is made of hard-drawn copper segments, separated by best mica insulation. The bearing bracket enclosing the commutator end of the armature is of such a form as to furnish protection from any dirt or dust falling upon the fan, but it is sufficiently open to allow the commutator to be readily inspected. The bearing brackets contain babbitt sleeves and are provided with lips which overhang flanges on the commutator cap and on the fan hub to prevent the throwing of oil. From the recesses in the bearing brackets formed by the lips, the oil is drained back to the oil cups through ducts in the castings. A cap covers the end of the shaft and bearing and prevents leakage of oil and entrance of dust.

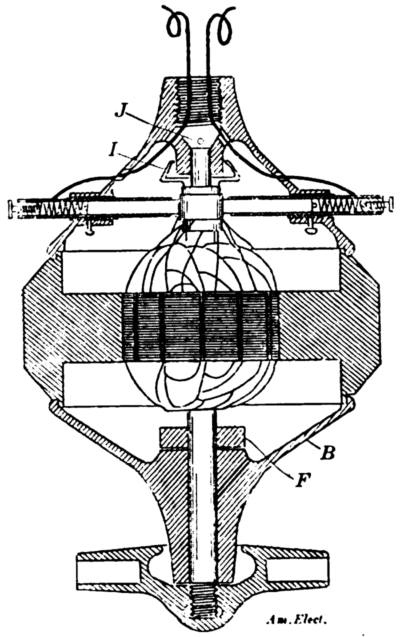


FIG. 72.—CROSS-SECTION OF DAYTON "JUNIOR" CEILING FAN MOTOR.

The brushes are of specially prepared graphite, circular in cross-section, and self-adjusting. The brush holders are a modification of the cartrdige type and are provided with triggers which bear upon the ends of the brushes, pressing them against the commutator. They allow almost the entire brush to be used up, and as there is no clamping, the brushes are not likely to break. The brushes can be readily renewed without disturbing any of the electrical connections.

The speed-regulating rheostat consists of an iron drum, upon which is wound German silver wire, embedded in and protected by a complete coating of white enamel, so as to eliminate any possibility of short-circuiting or grounding on the adjacent frame. The drum is mounted on a porcelain base carrying the speed-regulating switch and binding posts, and located within the pedestal.

These motors are wound for operation on standard direct-current circuits of 110, 220 and 500 volts. The field magnet coils are connected in series with the armature for all voltages. This type of motor is also made with the bracket form of mounting, as shown in Fig. 75. The fan can be turned to any desired position by the adjustment of a single hand screw, and the adjustment can be made while the fan is running at full speed. The motor frame swivels upon a ball and socket joint and has a horizontal range of adjustment of 180° and a vertical range of 45°.

The Western Electric Company's ceiling fan motors are shown by Figs. 76 and 77. Fig. 76 is a cross-sectional view of the Western Electric Standard ceiling fan motor. It is bipolar and has a slotted drum armature, the core being mounted directly on the shaft. The yoke ring and magnet poles are one casting of semi-steel. The armature winding is of double silk-covered wire wound in round holes and insulated from the core by pressboard tubes and end discs. The field magnet coils are wound in four sections, each section being thoroughly insulated with a double wrapping of heavy insulating tape dipped in Sterling insulating varnish. As in the desk fan motor, the armature is of large diameter in order to obtain a large number of slots and coils.

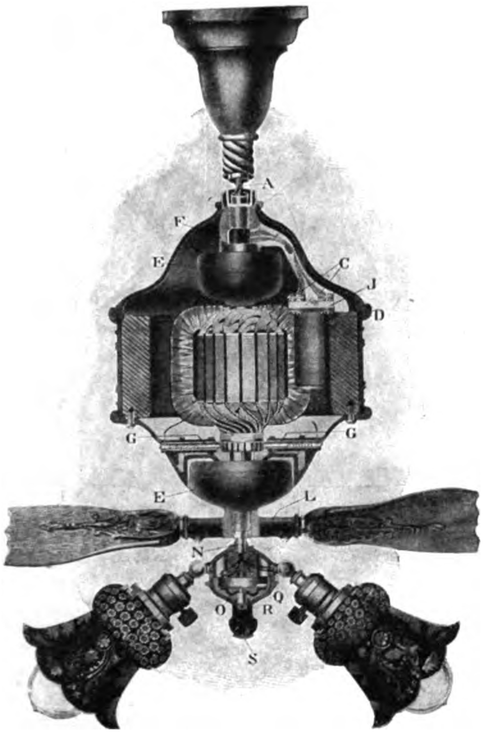


FIG. 76.—SECTIONAL VIEW OF STANDARD CEILING FAN MOTOR.

These machines are equipped with non-spillable oil reservoirs, which flood the bearings constantly with oil. The well is partly covered and a flange extends from the top of the well nearly to the surface of the oil, somewhat like an invertible inkstand, and this prevents the oil from spilling when the motor is laid on its side or even inverted. There is left a sufficient opening around the shaft to allow thorough washing of the well with benzine at the end of the season.

The brushes and holders are of the cartridge type, and the brushes are graphite pencils, each pressed toward the commutator by a helical spring behind it. The spring is designed to give a constant pressure to the brush until it is almost entirely used up.

The weight of the motor is supported by a strong cast-iron bracket fastened to the frame with machine bolts. The bracket also supports the upper bearing and a steel tube extending through the armature shaft, which is hollow. This tube contains a six-wire cable, including the wires for the chandelier lights and the wires connecting the speed-regulating rheostat to the switch. The rheostat, which gives three speeds to the fan, is made of German silver wire wound on an iron drum and embedded in a coating of white enamel. The rheostat is mounted on a porcelain base screwed to the cast-iron bracket. The base serves as a connection board, having six binding posts for connections of the chandelier lighting leads and rheostat leads.

The upper cover can be removed to get at the upper oil well and the connection board without taking the fan from the ceiling hook. The bearings are of babbitt and are self-aligning.

The blades are white basswood and have a sweep of 60 inches; the width across the face is 8¾ inches. They are pitched to give an unusually large wind output, while the input is only 120 watts. The speed is 210 r.p.m. These motors are wound for 110, 170, 220, 250 and 500 volts; the 170-volt and 250-volt motors are intended to run in groups of three and two, respectively, in series on 500-volt circuits, in which case a wall switch rheostat for three-speed control is furnished.

Fig. 77 is a cross-sectional view of the Western Electric Company's "Western" ceiling fan motor. This is a single-speed motor. It is bipolar and has an armature similar to that of the company's Standard machine just described. The field magnet yoke is of a special grade of soft cast-iron, and the magnet poles are of forged wrought iron, bolted to the yoke. The poles have extended tips which give the pole-faces a large angle of embrace; the coils are wound on pressboard spools and are of small diameter as compared with the size of the pole-face. The brackets supporting the upper bearing and switch and the upper covering to which the suspension rod screws, are cast integrally with the frame. The Western fans are equipped with oil reservoirs, but they do not have the non-spillable feature of the Standard oil wells, although the method of lubrication is the same. Before removing the fan from the ceiling hook, the oil should be withdrawn from the wells by means of a small oil pump provided for this purpose. The switch in the upper part of the motor is operated by a key and a rod extending through the hollow armature shaft.

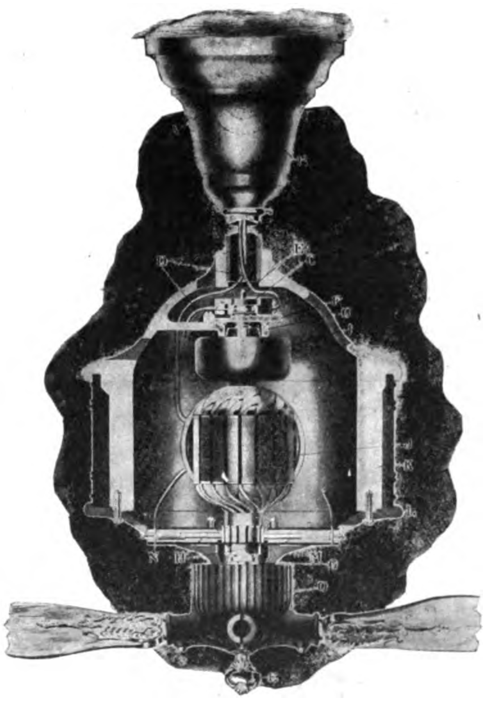


FIG. 77.—SECTIONAL VIEW OF WESTERN CEILING MOTOR.

The Western fans are furnished with or without the switch; the fan with the switch is designated "No. 1," and the other is "No. 2." No. 1 motor is wound for 120, 220 and 500 volts, while the No. 2 machine is designed to operate singly on 110, 170, 220, 250 and 500 volts or in series groups of two 110-volt fans on a 220-volt circuit; five 110-volt fans on a 550-volt circuit; three 170-volt fans on a 500-volt circuit, or two 250-volt fans on a 500-volt circuit. The blades are of white basswood, free from blemish, and have a sweep of 54 inches. The motors run at 200 r.p.m. with an electrical input of 90 watts.

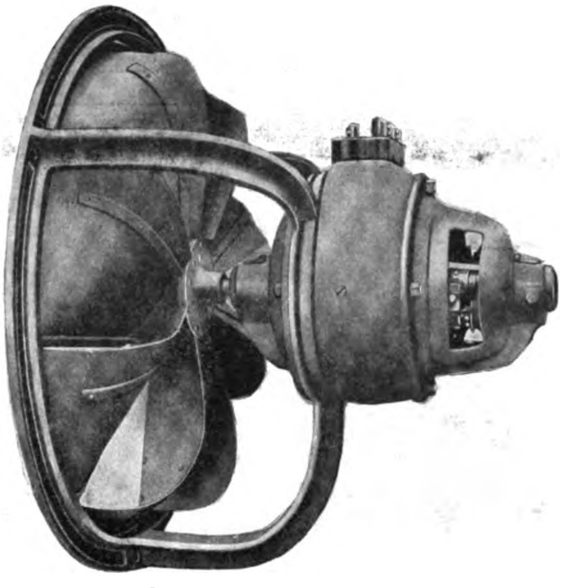


FIG. 78.—WESTERN ELECTRIC 24-INCH VENTILATING FAN.

Fig. 78 illustrates one of the Western Electric Company's ventilating fan outfits. This comprises a standard power motor mounted as shown in the engraving. The machine is multi-polar, with a cast-steel yoke ring to which cast-steel magnet poles are bolted. The poles are of circular cross-section where the coils embrace them, and are provided with polar extensions. The armature is of the usual slotted drum type, and is equipped with form-wound hand-insulated coils. The field magnet coils are machine-wound also, and thoroughly insulated. These outfits are built in sizes ranging from 24 inches to 72 inches fan diameter; the speeds range from 750 to 270 r.p.m. Similar outfits are also built in sizes of 12 and 16-inch fan diameters; these are equipped with bipolar motors of the same type as the Western Electric desk fan motor.

Figs. 79 and 80 illustrate the desk and bracket motors of The Robbins & Myers Co., Springfield, Ohio. The motor is a bipolar machine with a slotted drum-wound armature of rather large diameter. The field-magnet is a single-piece casting of iron and the coils are form-wound and hand-insulated. The armatures are machine-wound, the slots being, of course, heavily insulated before the winding process begins. The brushes and brush-holders are of the pencil and cartridge type, the brushes being 5/16-inch carbon pencil 1¼ inches long. The holders are mounted in insulated clamps in the rear journal cap and the complete holders and brushes may be removed without disturbing any connections or other parts of the machine. The commutator is insulated with mica throughout and the leads from the armature are bound to an asbestos insulating ring on the rear collar of the commutator in order to obviate the liability of their breaking by reason of vibration or rough handling of the machine in transit. An unusual feature in machines of this size consists in the use of a journal sleeve which is adjustable to take up wear. The sleeve is split lengthwise along the top and fits snugly into the central hole of the housing. Two screws are set into the end of the hub at such an angle that setting them up draws the split sleeve more closely around the shaft. Lubrication is provided by underfeed wick oilers.

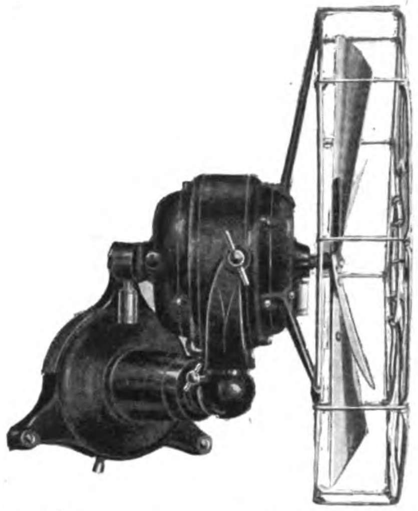


FIG. 80.—ROBBINS & MYERS BRACKET MOTOR.

The machines are provided with three-speed rheostats and switches, which give 1000, 1400 and 1800 r.p.m. for the 12-inch fan, and 800, 1150 and 1500 r.p.m. for the 16-inch fan; the regulating switch also serves to break the circuit for stopping the machine. The switch parts are insulated with mica, and the resistance wire is wound on a triangular iron frame heavily insulated with asbestos. The power consumption of these machines ranges from 35 to 45 watts for the 12-inch fan, and from 85 to 95 watts for the 16-inch fan, according to the actual voltage on the various circuits for which the motors are wound. The machines are built for the standard direct-current circuits of 110, 220 and 250 volts. When two or more motors are operated in series, the regulating switches are constructed so that they cannot open the circuit, but the speeds of all of the fans may be regulated, of course, by any one switch, or by two or more in combination. The mounting of these machines has been changed from a universal joint to the swivel and trunnion style here shown.

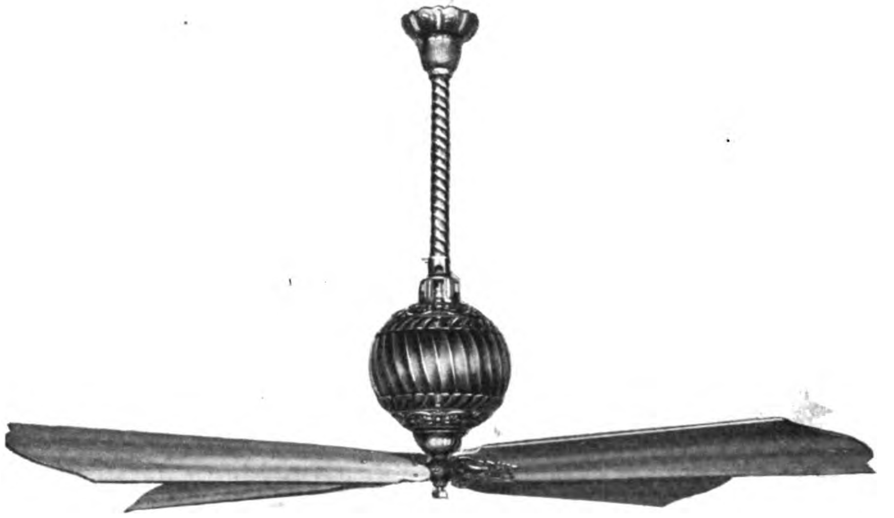


FIG. 82.—ROBBINS & MYERS STYLE "A" CEILING MOTOR.

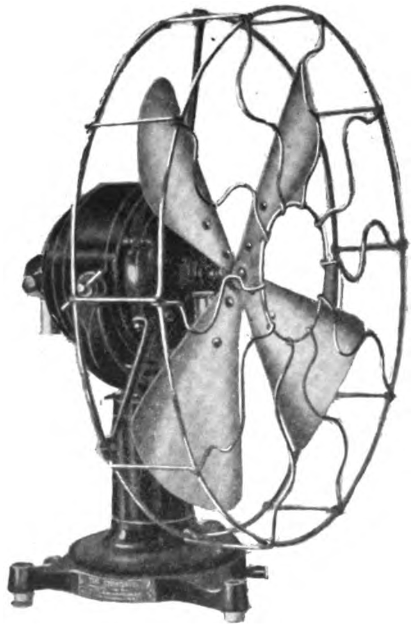


FIG. 79.—ROBBINS & MYERS DESK MOTOR.

Fig. 81 illustrates the Robbins & Myers oscillating desk fan brought out this year. The motor is of the same general construction as the standard machine just described, but it is pivoted on a ball-bearing in the pedestal so as to swing about its vertical axis. It is caused to oscillate by a deflector plate carried at the upper end of an arm which is pivoted to the lower part of the fan guard. The lower extension of this arm carries a counterbalancing weight and is arranged to impinge against two rollers mounted adjustably on the base. These rollers may be set at any point within a reasonable range and their position determines the angle through which the motor oscillates. When the lower end of the deflector arm strikes against one of the limit rollers, the arm is thrown over to the other position, shifting the deflector blade to the opposite side of the horizontal axis of the machine and thereby reversing the direction of movement about the vertical axis.

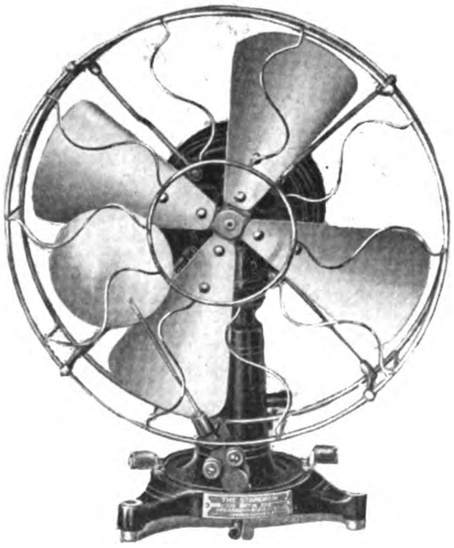


FIG. 81.—ROBBINS & MYERS OSCILLATING MOTOR.

Fig. 82 shows the Robbins & Myers "Style A" ceiling fan motor. This is a bipolar machine with a cast-iron yoke-ring to which drop-forged steel magnet poles are bolted; the poles are provided with extended tips so as to increase the area of the air-gap. The magnet coils are form-wound, taped, dipped in Sterling varnish and baked. The armature core is slotted and drum-wound; the coil slots are insulated by fibre troughs 1-64 inch thick and the coils are wound directly into the slots. The machine is usually furnished with four fan

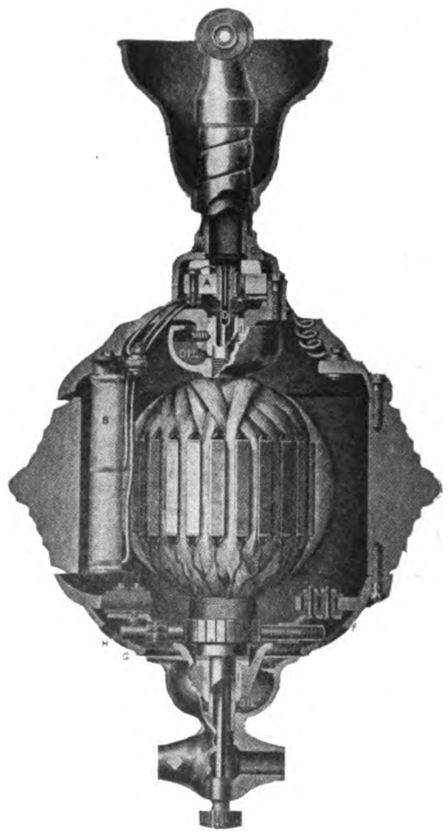


FIG. 83.—CROSS-SECTION OF STYLE "B" MOTOR.

blades and wound for 110, 170, 220 and 250 volts. The 170-volt and 250-volt motors are intended to be operated in series on 500-volt circuits, and when equipped with switches one motor of a series may be cut out without interfering with the other motor or motors. The sweep of the blades is 60 inches and the speed is 200 r.p.m. The "Style B" Robbins & Myers ceiling fan is somewhat similar in external appearance to the "Style A" machine, but the construction of the field-magnet is different. Fig. 83 is a sectional elevation of the motor. The field-magnet is a single-piece iron casting of the shape shown by Fig. 84. This construction provides a large air-gap area in comparison with the magnet-core area and yet allows the field-magnet coils to be put in place and withdrawn without necessitating removable poles or shoes. The other details of construction and insulation are similar to those just described in connection with the "Style A" machine. In both machines cartridge brush-holders and carbon pencil brushes are used. The arrangement of the armature shaft and switch is also similar in the two machines. The armature shaft is hollow, in order to permit the switch spindle, *D*, to pass up through it from the thumb piece, *E*, at the bottom of the fan, to the switch, *A*, at the top. The switch, in conjunction with the resistance coil, *B*, gives two speeds to the 110-volt and 220-volt machines. The motor is not furnished with the switch and resistance unless so ordered, the construction being such that the switch and resistance can be inserted or omitted without changing any of the remainder of the structure.

The bearings are lubricated by immersion in two large oil baths or reservoirs, the cups of which are mounted on the armature shaft and revolve with it. The basin or cup at the bottom of the shaft is cast solid with the fan-blade hub, as indicated in the engraving.

In addition to these machines the company has brought out a standard 500-volt fan, which runs at 200 r.p.m. and requires 0.2 ampere at the rated voltage. The general construction is similar to that of the two fans just mentioned, but more room is provided for the windings in order to permit the use of the extra-heavy insulation

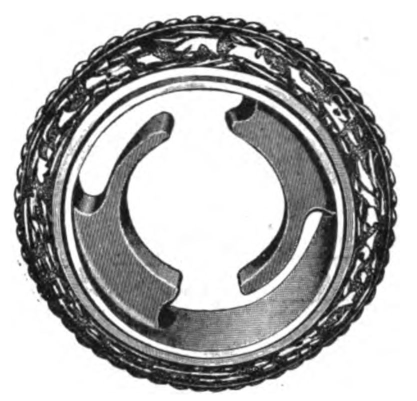


FIG. 84.—FIELD MAGNET, ROBBINS & MYERS STYLE "B" CEILING MOTOR.

The ceiling fan motor of the Century Electric Company, St. Louis, Mo., illustrated by Fig. 86, is a single-phase alternating-current machine, and has the distinction of including in its construction a practically separate starting motor. The working motor is of the squirrel-cage induction type with an external rotor mounted in the main casing, which revolves and carries with it the fan blades. Fig. 87 is a sectional elevation of the machine. The stator, *J*, is mounted on the stationary part of the structure, which also carries a bi-polar starting magnet, *H*, the cores of which are parallel to the axis of the machine. The revolving member which carries the rotor also carries a three-pole armature and three brushes located in between the three armature poles. Each armature pole carries a coil and the three coils are connected together star fashion, and their free terminals are connected to the three brushes. The brushes are pressed by helical springs against a two-part commutator, to the segments of which the field coils are connected, one terminal of each field coil being led to each of the segments, and the other field terminals being connected to the line. This obviously makes the starting motor a series machine of the simple three-coil armature type which has been used to a considerable extent in very small battery fan motors. The brush-holders are heavy castings, and the relation between the weight of the brush-holders and the tension of the springs which press the brushes against the commutator is such that the holders are thrown back by centrifugal force when the armature reaches the proper speed for the induction motor to take hold and bring the armature up to normal speed.

The armature shaft is hollow and revolves about a long hollow axle, *D*. At the lower end of the shaft is provided a ball bearing consisting of hardened steel washers, *M*, and steel balls, *N*. The bearing is immersed in an oil reservoir, *K*, which is attached to the stationary part of the machine, of course. The suspension hook, *B*, is insulated from the stem of the machine by means of an insulator, *C*, and a felt strip, *E*, is interposed to take up any vibrations which would otherwise be transmitted to the hook. The standard windings are for 100 to 110 volts and 60 cycles, but machines are supplied for any lower voltage and frequency desired.

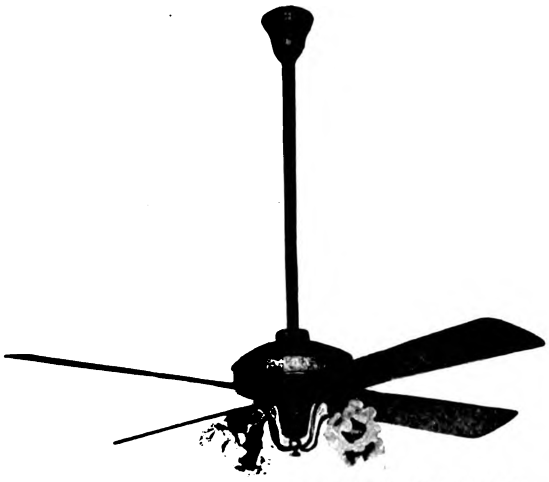


FIG. 86.—CENTURY CEILING FAN MOTOR.

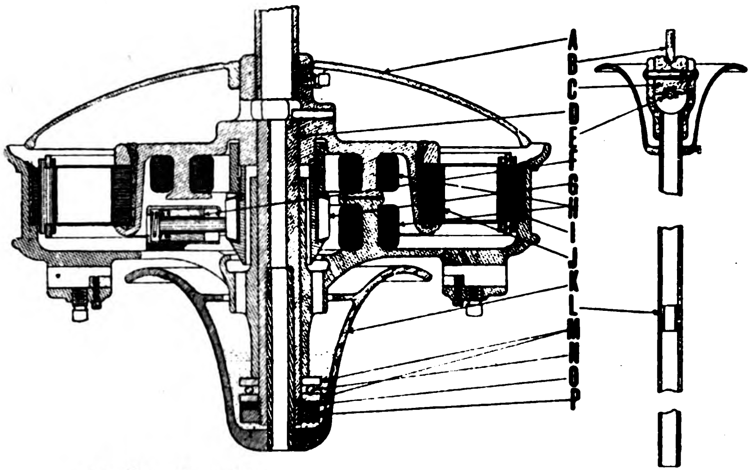


FIG. 87.—SECTIONAL ELEVATION OF CENTURY CEILING MOTOR.

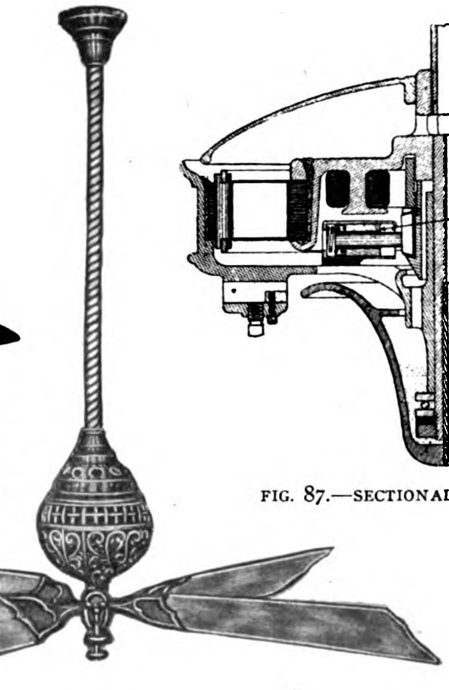


FIG. 85.—TUERK ALTERNATING-CURRENT CEILING MOTOR.

Fig. 85 shows the Tuerk ceiling fan motor built by the Hunter Fan and Motor Company, Fulton, N. Y. The motor is of the squirrel-cage induction motor type, with an ingenious speed-reducing arrangement of leather-faced friction wheels between the motor shaft and the fan shaft. The blades have 60 inches sweep and their speed is 175 r.p.m. The motor requires 100 watts, and is wound for all standard alternating-current voltages, and for both high and low frequencies.

The direct-current ceiling fan motor of the Sterling Electric Motor Company, Dayton, Ohio, is shown by Fig. 88. The motor is a bi-polar machine with the field-magnet yoke-ring and poles cast in a single piece and equipped with form-wound coils, taped and varnished. The armature, which is of the slotted-drum type, is also equipped with form-wound and individually insulated coils. A single bearing of unusual length is employed, and this is lubricated from the oil reservoir shown in the engraving. The speed-regulating rheostat is of fireproof construction, and is located above the motor, so that it has full ventilation, and the heat generated in it cannot affect the bearings or windings of the machine. The regulating switch is also located at the top of the motor and operated by means of a spindle extending through the hollow armature shaft, as in the cases previously cited, and terminating in a key below the fan-blade hub. The switch has been very greatly strengthened since last year; the old construction showed a tendency to become weak and cause trouble in the contacts. The base plate of the fan has also been strengthened in order to insure rigidity and maintain the proper relations between the armature and the field-magnet under all conditions. The brush-holders are of the usual cartridge type, with radially-fed brushes which can be removed and replaced without disturbing any other part of the machine. Every part of the machine is made to gauge by automatic machinery, so that all repair parts are strictly interchangeable with the originals. The motor is wound for the usual direct-current voltages.

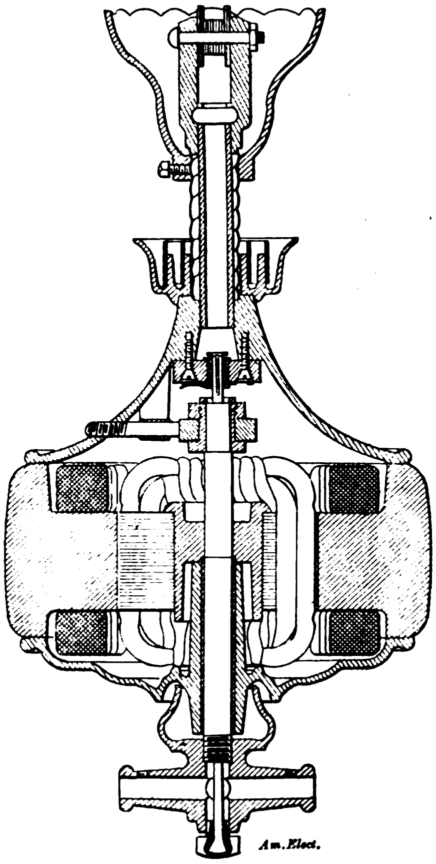


FIG. 88.—STERLING CEILING MOTOR.

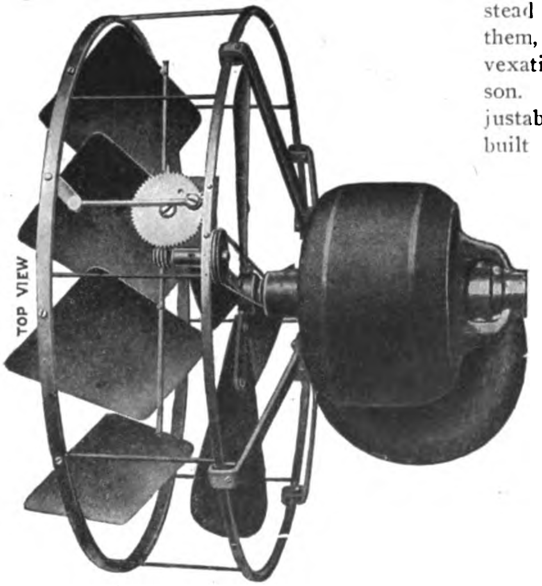


FIG. 89.—COLEMAN FAN GUARD.

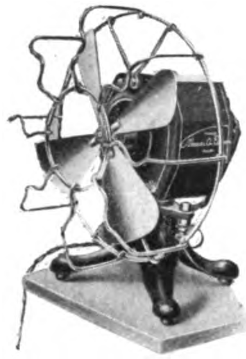


FIG. 91.—EDISON BATTERY MOTOR.

The Coleman combined fan guard and deflector, Fig. 89, made by the Coleman Manufacturing Company, New York, has been improved in several details since last year. The deflecting vanes are coupled by two links, and one of the vanes is also linked to a crank-pin on the small worm wheel at the top of the guard. This wheel is driven by a worm, the shaft of which receives motion through a grooved pulley and a leather belt passing around the motor shaft. The grooved pulley has been made larger this year, and the use of two links, coupling the vanes in two pairs, instead of a single bar coupling all four of them, has eliminated a minor but very vexatious trouble that developed last season. The supports of the guard are adjustable to fit any make or size of motor built to drive the ordinary propeller or disc type of fan of 16 inches diameter or less.

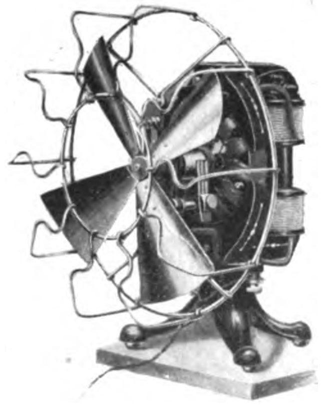


FIG. 90.—EDISON BATTERY MOTOR.

The battery fan motors of the Edison Manufacturing Company, New York, are illustrated by Figs. 90 and 91. The former is the larger of the two; it is a bipolar machine, with a field magnet of the Van Depoele type, the magnet being of cast-iron in a single piece. The armature core is liminated and slotted around the periphery; the winding is of the Gramme ring type. The motor will run a 9-inch fan 150 hours on one charge of the battery ordinarily supplied with it, which is of the well-known Edison-Lalande type. The field-magnet of the smaller motor, Fig. 91, is also bipolar, but of the enclosed type, and the magnet and yoke-ring are cast in a single piece. The armature is of the polar type, with three polar projections, and the core is laminated. The motor drives a 7-inch fan and will run 150 hours on one charge of the battery. The latter is of the same type as the battery used with the 9-inch machine, the only difference being in the number of cells required.

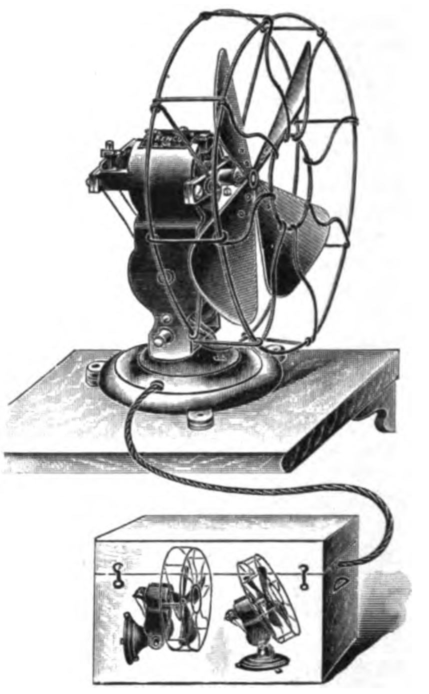


FIG. 92.—KNAPP BATTERY MOTOR.

Fig. 92 illustrates a new battery motor brought out this year by The Knapp Electric and Novelty Company, New York. This little machine shows a remarkable efficiency for one of its class. The field-magnet consists of stamped steel polar extensions mounted on the ends of a round wrought-iron core. The armature is of the drum type with six slots and teeth. The machine is series-wound, of course, and supplied with either one of two windings; one for 2 volts, at which e.m.f. the motor requires 1½ amperes, and the other for 5 volts and ½ ampere. The brushes are of strip copper and the tension is adjustable, which is an unusual feature in machines of this type. The field-magnet is pivoted to the base and can be tilted so as to direct the stream of air below the horizontal line or above it; the pivot mounting is provided with positive stops so that the machine cannot be slipped out of position. The magnet can be tilted backward to such an extent as to convert the machine into a bracket motor, the base being merely screwed to the wall instead of mounted on the horizontal support. The motor is ordinarily supplied with twenty cells of dry battery which are connected four in series and five in multiple for operation with the 5-volt winding. It is stated that about 300 hours of service can be obtained from first-class dry batteries if the machine is not used more than 4 hours a day. For more continuous service the life of the battery is, of course, much shorter.

Figs. 93, 94 and 95 illustrate some of the types of electrically-driven fans built by the B. F. Sturtevant Company, Boston, Mass. Different types of motors are used for different classes of service. Fig. 93 shows an eight-pole open machine direct-connected to a cast-iron or Monogram blower type of fan; Fig. 94, an eight-pole semi-enclosed motor direct-connected to a fan of the propeller type, and Fig. 95 illustrates the enclosed bipolar machine as used for driving fans of the propeller type. The motor in Fig. 94 can be made fully enclosed by the use of covers to close up the openings in the case. The field magnet ring of the bipolar machine is of cast-iron with detachable steel or wrought iron magnet cores. The machines having steel cores are provided with polar extensions cast integral with the magnet cores, and those having wrought iron cores are provided with cast-iron shoes. The field magnet coils in all cases are form-wound of double cotton-covered magnet wire and are insulated in a thorough manner. The coils after being assembled upon the magnet cores are given a break-down test of 1500 volts (alternating) applied for one minute.

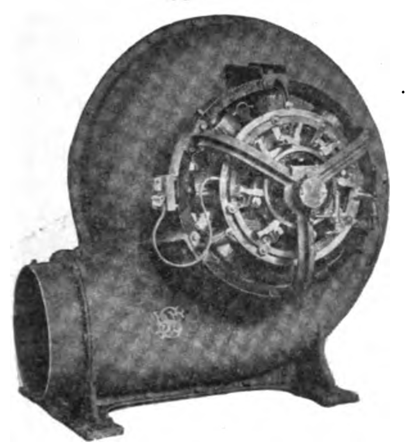


FIG. 93.—STURTEVANT EIGHT-POLE MOTOR.

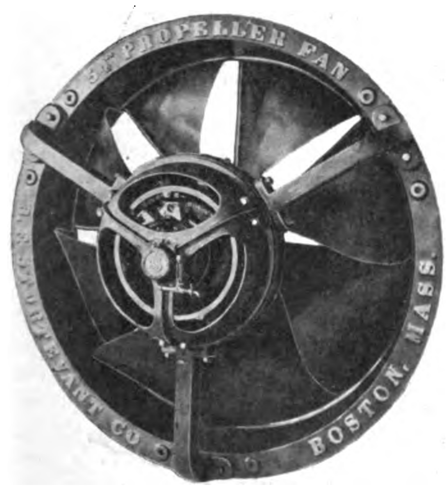


FIG. 94.—STURTEVANT EIGHT-POLE VENTILATING FAN MOTOR.

All the motor armatures are of the toothed-drum type, having form-wound armature coils insulated in the most thorough manner by the use of heavy cotton tape and fish-board and horn fibre. They are thoroughly saturated with a waterproof insulating compound and baked for a sufficient length of time to drive out all moisture. The commutators are constructed only of drawn or drop-forged copper bars insulated with the most carefully selected amber mica and thoroughly tested before being attached to the armature. The insulation between the segments and the shell is of micanite, no fibrous material of any kind being used in the commutator construction. The commutators are assembled under great pressure at a high temperature, thus assuring solid construction, and one in which the mica between the segments is not liable to creep and produce sparking due to high mica.

On motors of ⅜ horse-power (driving a 30-inch propeller fan) and under, the brushes are round carbon pencils fed in cartridge-type holders by helical springs. In larger machines ordinary rectangular carbon brushes are used, fed in holders of the sliding-socket shunted type, the pressure being regulated by an adjustable flat phosphor-bronze spring. All motors are furnished with self-oiling, self-aligning boxes. Before being shipped, every machine is given a full load run for a sufficient length of time to attain maximum temperature, and every part is critically examined before it leaves the testing department. Every means possible is employed to insure that nothing but strictly first-class machines leave the works.

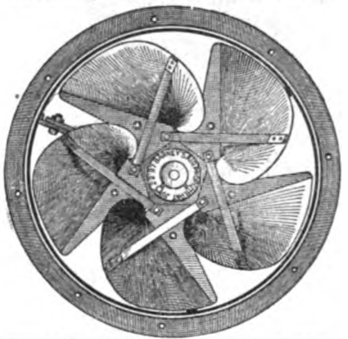


FIG. 96.—BARNEY AIR PROPELLER.

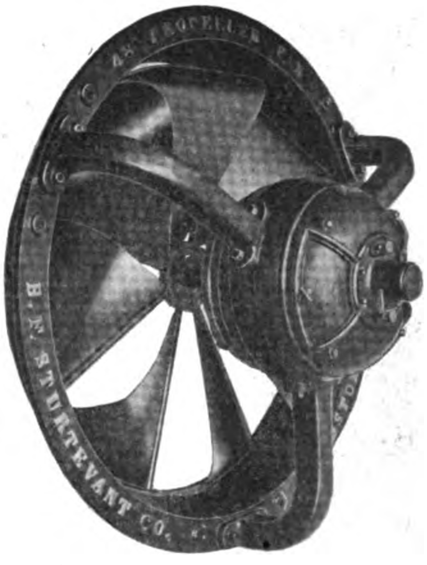


FIG. 95.—STURTEVANT BIPOLAR VENTILATING FAN MOTOR.

Figs. 96, 97 and 98 illustrate the fans of the Barney Ventilating Fan Works, Boston, Mass. The type shown by Fig. 96 is known as the Barney air propeller, while the fan shown by the other two engravings is referred to as a compound ventilating wheel. The blades of the propeller fan are made of Harvey-cleaned steel and are of rather unusual shape, as the engraving shows. The outer edges are braced to the central hub so as to avoid vibration while running, and the gradual curve of the blades is said to result in the delivery of a practically solid stream of air. The shaft runs in two self-adjustable ball bearings which are provided with automatic lubrication; both of the bearings are on the front side of the fan. The fan is well adapted for direct connection to an electric motor and is extensively used that way. The diameters range from 12 inches to 84 inches. The compound ventilating wheel is illustrated by Figs. 97 and 98. It is provided with a double set of blades which are curved somewhat similarly to the blades of the simple propeller fan. The two series of blades are flared in opposite directions, the blades on the rear being adapted to draw air into the wheel, while those on the other side beat away the surrounding air and tend to form a vacuum in advance of the column of air drawn through by the first set of blades. These fan wheels are built in diameters ranging from 24 inches to 84 inches.

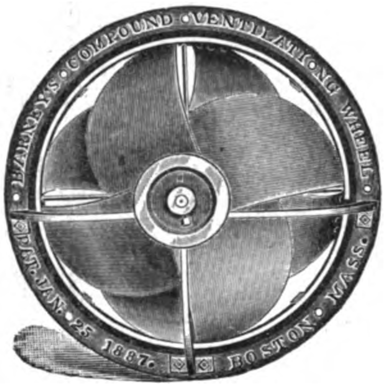


FIG. 97.—BARNEY COMPOUND VENTILATOR.

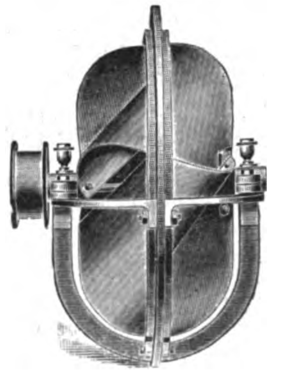


FIG. 98.—EDGE VIEW OF BARNEY COMPOUND VENTILATOR.

Figs. 99 and 100 illustrate two forms of direct-driven Davidson ventilating fans built by the Massachusetts Fan Company, Waltham, Mass. The shape of the blades is the same in both; they are built with a compound propeller curve such that the fan picks up the air at a very low velocity and delivers it at a comparatively even pressure throughout the whole surface of the blades. This construction is said to obviate back-lash entirely. The blades are made of cold-rolled copper, a composition commonly called yellow metal, or galvanized steel, according to the conditions of operation. When the fan is to be used for moving steam or vapors containing corrosive gases, such as are encountered in dye houses, bleacheries, sulphite mills, etc., either the copper or composition blades are employed. The standard construction for moving air only is galvanized steel. The fan blades are attached to a long cast-iron hub at two points and at the outer rims they are riveted to a heavy endless wrought iron ring which is stayed to one end of the cast-iron hub, as clearly shown in Fig. 100. This construction is said to make the fan capable of withstanding enormously high speeds, 10,000 feet per minute at the rim being the limit ordinarily. The most efficient speeds, however, range from 4400 to 6000 per minute at the rim. The bearings are of the reservoir self-oiling type, the oil being fed to the bearings by wicking in the smallest sizes and by oiling rings in moderate and large sizes. All of the bearings are fitted with removable babbitted sleeves, hammered and reamed to fit the shaft. When the fans are used in places that are inaccessible for oiling, bronze-graphite sleeves are used. A special feature of the Davidson fan is a ball-bearing thrust collar which takes the backward thrust of the fan blades and is said to reduce the required driving power from 20 to 30 per cent, as compared with the same fan used without the ball-bearing thrust collar. The fans are built in sizes from 12 inches to 60 inches in diameter and for all classes of service. Direct-driven fans from 12 inches to 48 inches in diameter are mounted as shown in Fig. 99, and larger fans are mounted as shown in Fig. 100. The motors are supplied for all of the standard direct-current voltages.

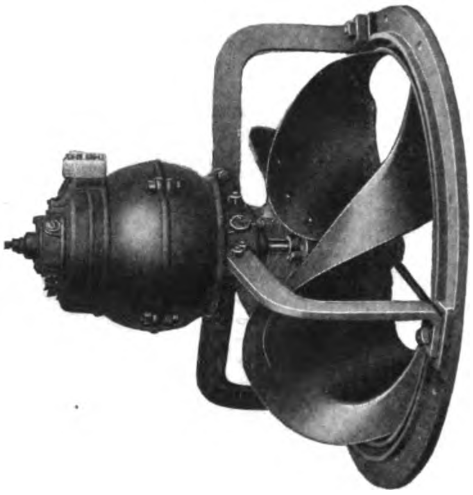


FIG. 99.—DAVIDSON VENTILATING FAN.

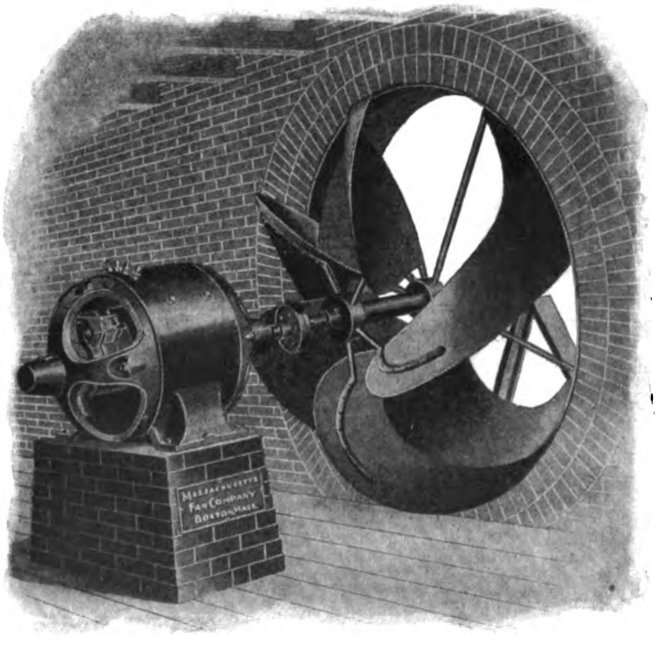


FIG. 100.—DAVIDSON VENTILATING FAN.

The American Blower Company, Detroit, Mich., builds a very complete line of ventilating fans of the disc type. Fig. 102 illustrates the direct-connected form of fan built in sizes ranging from 18 inches to 42 inches in diameter. The mounting for larger fans is very similar to that shown here, the chief difference being in the addition of stiffening flanges to the rim of the casing. A notable feature of the "A. B. C." fan is the number of blades; twelve of these are used and they are so disposed that each blade overlaps the one next to it. The blades are riveted to two large central discs and are also braced to a third smaller disc, as shown in Fig. 101. These central discs not only serve to stiffen the fan, but prevent any backflow of air through the center, which is one of the disadvantages of the ordinary form of disc fan. The peripheral speeds range from 4500 to 9000 feet per minute. All of the "A. B. C." fans are provided with ring-oiling bearings of the type shown by Fig. 103. Each bearing has two oil rings and is self-aligning in all directions, the journal housing being mounted on a horizontal pivot and the bracket which carries this pivot being mounted on a vertical swivel in the main framework. The bearings are provided with babbitt sleeves or liners which may be replaced without dismantling the journal box. The motors are supplied for all of the standard direct-current voltages.

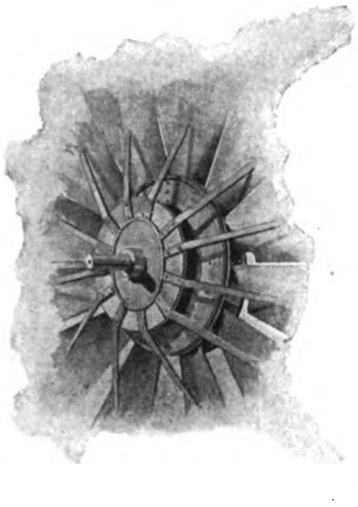


FIG. 101.—DETAILS OF AMERICAN BLOWER FAN BLADES.

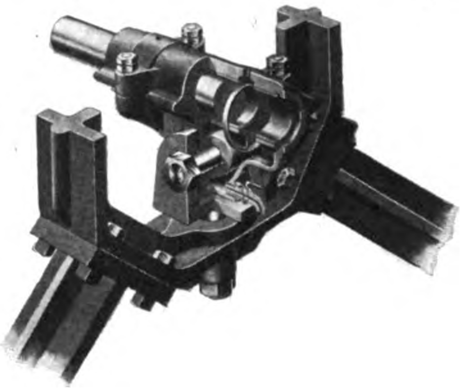


FIG. 103.—BEARING OF AMERICAN BLOWER FAN.

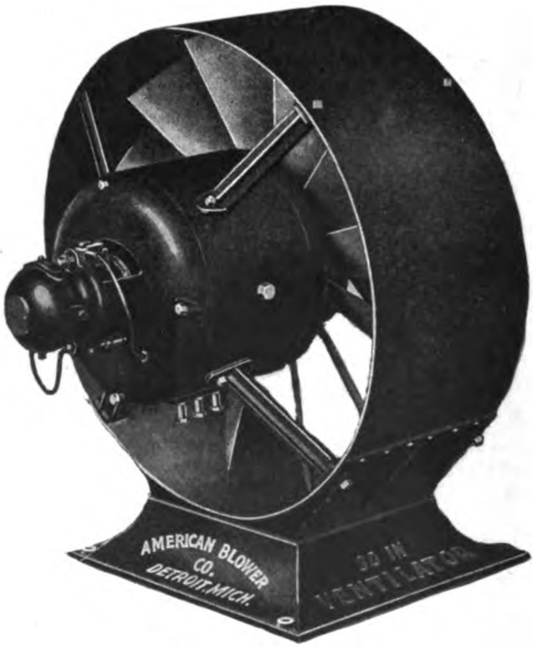


FIG. 102.—AMERICAN BLOWER VENTILATING FAN.

Abstracts from Foreign Contemporaries

New Surface Contact Railway System.—The London *Electrician* describes the "G. B." surface contact system, a demonstration of which was recently given at Ilford. As shown in the illustrations, the bare line conductor, consisting of stranded galvanized iron cable, is drawn through plain butt-jointed 5-in. stoneware pipes, and is suspended at convenient intervals by vitrified clay insulators. If found necessary, the electric conductivity of the cable may be raised by including a copper conductor. The galvanized steel pivots of the insulators are carried through one side of the glazed pipe conduit, and are all electrically connected together and with the track rails. This is to ensure a direct path to the rails for any possible leakage current from the cable, thus practically preventing a serious difference in pressure between the studs and the rails due to surface leakage on the clay insulators. Although the total depth of excavation does not exceed 19 in. in standard practice, even this depth may be reduced by 6 in. or 7 in. for special purposes. As seen from Fig. 1 the whole conduit is embedded in concrete. Access boxes, placed at intervals of from 200 yds. to 400 yds. along the track, consist of cast-iron bodies with manganese covers. The two cable ends, entering a box at opposite sides, are led to terminal bars, mounted on insulators within the box. Drainage pipes, leading from the bottom of these boxes, conduct away any water which may accumulate in the earthenware pipes. Every 7 ft. 6 in.—corresponding to the distance between studs—a short vertical earthenware tube is cemented to the main horizontal pipe (Fig. 1). Into this vertical portion of the pipe system the laminated stalk of the stud is let, the upper part of the intervening space between it and the tube being subsequently filled up with bitumen, a packing of jute yarn preventing this material from falling through. A loosely fitting contact plunger, consisting of a laminated body and a carbon contact piece, slides in the brass-lined fork of the stalk as indicated in Fig. 1. It is electrically connected with the stalk by flexible copper conductors and is held up from the cable against the force of gravity by an insulated phosphor-bronze spring, the separating distance being about 5-16 in. The stalk is connected to the cast-iron stud by a somewhat flexible joint, but this does not prevent it making good electrical and magnetic contact. A recessed granite block receives the stud which is level with the track and whose surface measures 2½ in. by 14 in. By directing the flame of a blowpipe against the stud, the bitumen beneath is made to melt and the stud as a whole may be withdrawn, this operation occupying, it is said, but seven minutes. In addition to the ordinary standard equipment, each car is provided with a magnet rigidly suspended beneath the car and a battery of accumulators. It may be mentioned that the accumulators serve for starting only, being charged up during ordinary running. One pole of the magnet is in the form of two parallel iron bars, and is suspended at a distance of about 2 in. above the centre of the track. Between these two bars are a number of iron tongues (Fig. 2), suspended by springs, but free to move a considerable distance up and down. These are all connected at their lower ends by one flat chain belt (not shown in the illustration), about ⅝ in. wide, which is kept parallel to the track at a distance of approximately ⅜ in. by the springs and tongues referred to. In order to have a continuous supply of current, the belt is made longer than the distance between any two studs. As the car comes over each stud both the flexible chain belt and the sliding plunger are attracted downwards, and the former, on coming in contact with the stud, completes the electric circuit. It is stated that the net force with which the plunger, weighing 6½ oz., is drawn downwards, is equivalent to the weight of 6 oz. at the beginning, increasing about 16 oz. when the carbon contact touches the cable. If a non-magnetic cable is used, the figures are given as 3 oz. and 6 oz. respectively. The gauge of the trial track, which was one-fifth mile in length, was 4 ft. 8½ in., and the paving consisted of granite in bitumen, granite in cement and hard wood. The steepest gradient was 1 in 32, the sharpest curve having a radius of 54 ft. A double-deck car, with a total seating for 54 passengers and fitted with two 25-h.p. motors and series-parallel controllers had been fitted up with the auxiliary equipment necessary for the new surface-contact system. Its weight, fully equipped, was stated to be 10 tons. When running empty round the track, the current taken by the car varied between 20 and 35 amperes, the latter current corresponding to the steepest incline, the pressure being kept constant at 500 volts. The leakage of the experimental track was measured and found to be 0.05 ampere; and it may be mentioned that the ground upon which the track was laid was very moist. When a bucket of water was thrown on the track, the leakage of current between the rails and a live stud began with 0.5 ampere, and then fell gradually. In order to show the current-carrying capacity of the contacts, the car brakes were applied and the car set in motion. By this means a current of about 95 amperes was taken through the studs. The energy absorbed for exciting the magnets was measured during the tests, and amounted to 325 watts. On one occasion, a stud was thickly smeared with mud, and the car slowly brought over it; this, however, did not prevent current being successfully picked up. In case a stud should remain alive after the chain belt has passed, the supply is interrupted by means of chains, fixed to the end of the car and trailing on the track, coming in contact with the live stud and causing a maximum cut-out on the car to operate.

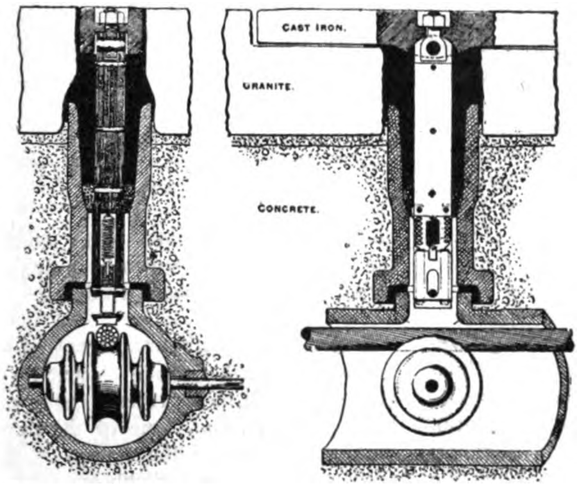


FIG. 1.—SECTIONS OF STUD.

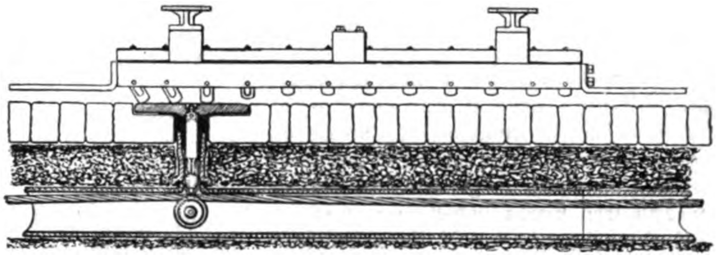


FIG. 2.—CURRENT-COLLECTING DEVICE.

Heat Transference Through Boiler Plates.—London *Engineering* contains a paper giving the results of an investigation conducted by the Physikalische Reichsanstalt on the passage of heat through metallic plates. It was necessary, first, to develop a suitable method, which was done by Holborn and Dittenberger. The experiments were completed by L. Austin. What has been investigated is the passage of heat from oil to water, or from water to oil, through an iron wall three centimetres in thickness. A certain transition resistance has to be overcome when heat passes from a solid wall to a liquid. The transition resistance is not so great as in the case of solids and gases, yet it is generally larger than the resistance which the metal itself offers to the passage of heat. The apparatus consisted of a small boiler of wrought iron, having two chambers separated by the plate to be investigated. Each chamber contained a stirrer, a suitable thermometer, and was heated by Bunsen burners. The dividing partition was drilled to receive thermocouples, by means of which the temperature gradient in the iron plate, and between the iron and liquid, could be determined. One of the first effects to be noticed was the decrease in the difference in temperature between the surface of the plate and the liquid, when the stirring apparatus was put into service. This difference decreased with increase in the speed of the stirrer, apparently approaching a limit. Measurements were made of the heat passing from the plate into the water, and in the reverse direction. The following results were obtained: With a heat flux from metal to water, the transition resistance varies between 1.2 and 2 centimentres of iron, according to the degree of boiling in unstirred water. Stirring reduces it to 0.75 centimetre. If the water is only warm, the resistance may be equivalent to 10 centimetres, which, by stirring, is reduced to 1 centimetre. When the water is not boiling, the resistance increases somewhat with a decrease in temperature. With a heat flux from water to metal, the transition resistance is constant with different temperatures, and is greater than with the reversed flux when the water is not stirred, and as great as with the reverse flux when the water is stirred. If the transition resistance be due to a film of water adhering to the iron that film should have a thickness of about 0.1 millimetre, since iron conducts 100 times better than water, and since a maximum resistance for water of 10 centimetres was observed. The thickness of this film is independent of the condition of the surface of the iron, as cleaning had no effect. It is thought that the vibration of locomotive boilers may have an effect somewhat analogous to mechanical stirring, and this would account for the better results obtained from such boilers, than from stationary boilers. While mechanical stirring would assist in raising the steam in boilers, its application seems to be impractical.

Tandem Connection of Induction Motor. —Ernst Danielson contributes to the *Elektrotechnische Zeitschrift* an article on the use of induction motors in rolling mills and in iron works in general. In a large Swedish iron works induction motors are used throughout, most of them being of the ordinary type, so that their speed cannot be easily varied. One motor, however, is used which, without losses in a rheostat, can be operated at the nearly synchronous speeds of 428, 375 and 333 r.p.m. The machine consists of a combination of two motors; the main motor, which is an ordinary 14-pole induction motor, and an auxiliary motor, which can be operated as well as a two-pole or as a four-pole motor. To get a speed of 428 revolutions the main motor is operated alone, while the auxiliary motor is without current. To get 375 revolutions, the auxiliary motor is connected so as to act as a two-pole motor and is connected in tandem with the main motor. To get 333 revolutions, the auxiliary motor is connected so as to act as a four-pole motor and is connected in tandem with the main motor. The power is always 150 horse-power. At 333, 375 and 428 revolutions and full load the efficiency is 87, 88 and 89 per cent and the power factor 81, 83 and 92 per cent. It is necessary to design the auxiliary motor so that the leakage is very small and the magnetizing current is also small. In the above motor only the direct tandem connection is used. If one would also apply the so-called differential tandem connection it would be possible to get with the same motor two other speeds, namely 500 and 600 r.p.m. It would only be necessary to provide the rotor of the auxiliary motor with slip rings. The author discusses the following three possible tandem connections between a main motor and an auxiliary motor. Fig. 3 shows the direct tandem connection; Fig. 4 shows the differential tandem connection in which the main motor is connected to the supply network, while Fig. 5 shows the differential tandem connection in which the auxiliary motor is connected to the supply network. The arrangement of Fig. 4 gives a better efficiency than that of Fig. 5, but in Fig. 4 the motor does not run up by itself to the desired speed while it does so in Fig. 5.

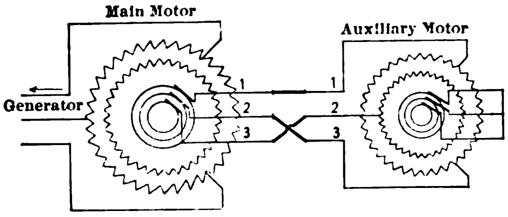


FIG. 3.—TANDEM CONNECTION OF INDUCTION MOTORS.

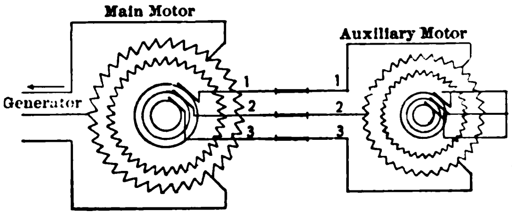


FIG. 4.—TANDEM CONNECTION OF INDUCTION MOTORS.

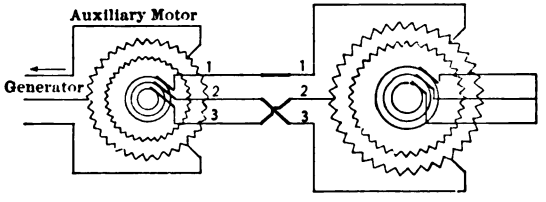


FIG. 5.—TANDEM CONNECTION OF INDUCTION MOTORS.

Electromechanical Compounding System. —The *Elektrotechmische Zeitschrift* describes in a recent issue the electromechanical compounding system of Routin. In the regulation of steam-driven dynamos, the speed must be adjusted by varying the admission of steam to the engine and on the other hand the voltage must be varied by changing the excitation. Both changes should be made simultaneously, but the changes of admission of steam require time, since the mechanical devices are subject to the law of inertia. The condition for the successful regulation is, that with increasing current consumption and with decreasing voltage or decreasing speed, the admission of steam should be increased and the excitation simultaneously increased, while with decreasing current consumption and increasing voltage or speed, both the admission of steam and the excitation should be diminished. The device of Routin, as shown in Fig. 6, consists of an iron core, on which is acting the difference of the ampere windings of a main current coil and of a voltage coil. Through the main coil flows the current given out in any moment from the machine, while the shunt coil (which is connected in opposition to the main coil), is connected across the terminals of the generator is in series with a resistance which may be regulated by a sliding contact. Simultaneously with this sliding contact, another sliding contact moves which, by its changed position on the resistance influences the excitation of the machine. The dimensions of the coils are so chosen that the action of the shunt coil is always superior to that of the main current coil. The iron core of the solenoid is coupled to the devices which determine the steam admission to the engine, and carries a weight which gives an attractive effort downwards. When the iron core sinks downwards the steam admission is increased, and if it rises upwards the steam admission is diminished. The motion of the iron core is the result of the differential action of the two ampere windings.

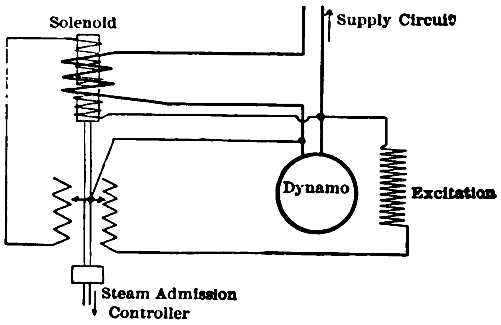


FIG. 6.—ELECTROMECHANICAL COMPOUNDING SYSTEM.

English Switchboard Practise. —The Stepney Borough Council electricity works are described in a recent issue of the London *Electrician*. One of the most admirable features of the station is the arrangement of the switchboard, which is simplicity itself. Where possible, all connections are quite permanent, and the few loose insulated wires are all labelled. Small conductors, such as voltmeter leads, are all enclosed in screwed steel barrels, from which they emerge through circular junction boxes fixed at convenient points. The board itself is divided into two sections, one of which is situated on a spacious gallery at the end of the engine room and the other immediately underneath, on the ground floor. It is built up of 2-in. slate panels carried by angle irons, and that portion on the gallery is divided vertically into three, the positive being on the right, the negative on the left and the neutral in the middle. The positive and negative panels are each provided with four main bus bars, as shown in Fig. 7. By means of short bars at right angles to these, and suitable plugs and sockets, any feeder can be plugged on to any bus bar. Similarly, separate bus bars may be employed for separate generators, or they may all be plugged together. This arrangement permits of feeders which supply distant points being raised to a higher potential than those supplying points close to the station. The dynamo cables come up through the gallery floor to the back of the board and are connected to their respective panels, but the feeder cables are carried upward and over the intervening space of about 4 ft. to the wall of the building and thence to the cable subway. Thus, dynamo and feeder cables never come into contact, and until the latter enter the street all positives are kept on one side of the subway and all negatives on the other, the neutrals being suspended from the roof.

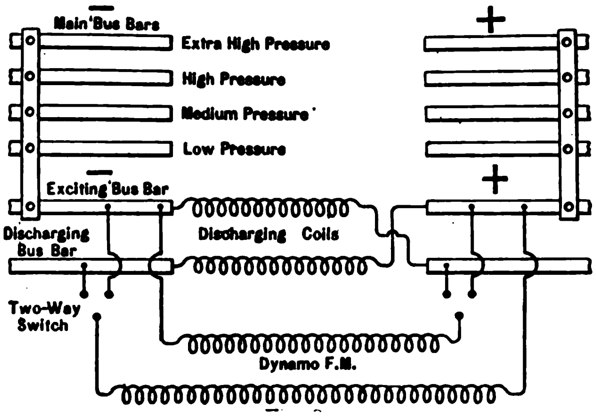


FIG. 7.—DIAGRAM OF CONNECTIONS.

The field switch is interlocked with the main switch in the usual manner and the field magnets may be excited at any voltage from 480 to 530, depending upon the voltage of the bus bar from which exciting current is obtained. There are eleven feeders in all, each of which is provided with a knife switch and ammeter. Referring to Fig. 7 it will be seen that there are two smaller bus bars immediately under the main bus bars, the top one supplying the exciting current, and the lower one is called the "discharging" bar. Instead of employing a separate coil for each dynamo for damping the rises of potential due to self-induction obtained when breaking the field, only two coils are used for all the machines in the station. According to the direction in which the fields are wound, they are connected up as shown in the diagram, and the result is a considerable simplication and reduction in the number of switchboard connections.

The Vogt Gas Engine.—A novel type of gas engine, which is, according to Mr. H. A. Humphrey, possessed of a number of distinct advantages over the usual type, is described by him in a recent issue of London *Engineering* in some detail. The most radical departure from the usual practice is the filling of the working cylinder with water. This cylinder is horizontal and opens at each end into two chambers, also filled with water. At the upper part of these chambers the air and gas are admitted . After an explosion has taken place in one chamber, the gases force down the water contained in it, and thus move the piston horizontally. At the end of the working stroke an air valve opens, admitting air under pressure, which drives out the products of combustion. On the return stroke the air valve closes, as does also the exhaust valve, and part of the water in the chamber is ejected through a special valve. The gas valve opens, admitting gas under pressure. Compression begins, the gas valve closes, and the compression of air goes on. At the end of compression the mixture is exploded, and the cycle is repeated, the same process being carried on in the other chamber. This method of operation gives two impulses per revolution. The power of the engine is controlled by stopping the escape of air from the cylinder on the return stroke, and by the amount of gas admitted and the quantity of water allowed to escape. The proportion of air and gas is constant for all loads. The presence of water in the cylinder enables the piston and stuffing boxes to be kept tight without much friction, as they are under water. It does away with the

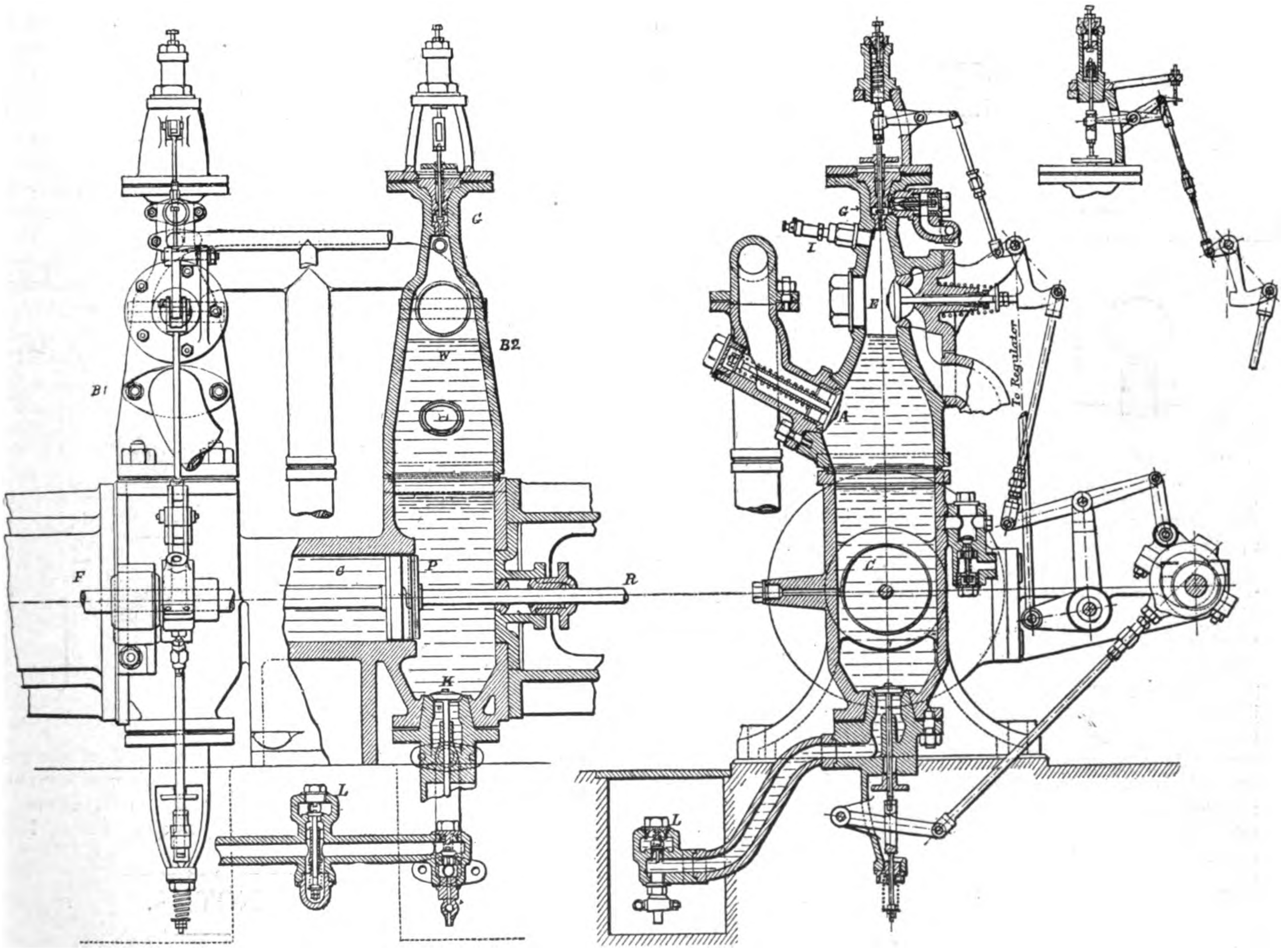
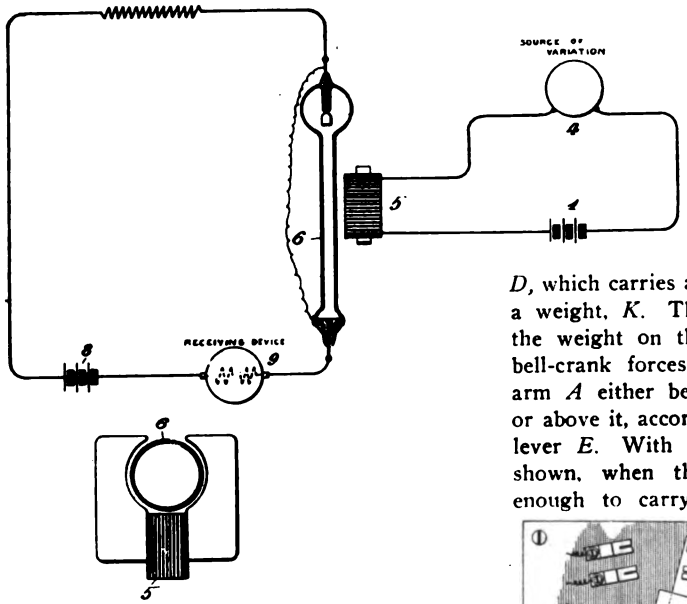


FIG. 8.—SEMI-SECTIONAL ELEVATION AND CROSS-SECTIONAL VIEW OF VOGT GAS ENGINE.

necessity of a water-jacket for cooling the cylinder, and prevents unequal expansion between the piston and the cylinder. At the end of each stroke a little fresh water is admitted to the cylinder, and part of the hot water is drawn off. As the gas does not come in contact with the working cylinder, it is not necessary that it should be clean. Any dust or soot will be carried off in the water. Tests of a small engine giving but 1¾ horse-power are said to have shown a gas consumption of only 16 to 18 cubic feet of London city gas per horse-power—a performance as good as that of a 200-horse-power gas engine of the ordinary type. Calculation shows that the speed of the piston may be five or six metres per second before the water column will be broken up. Four metres per second is generally high enough for the piston speed of a gas engine. It is stated that a 1000-horse-power engine is to be built, in order to test the capabilities of a large machine of this type.

SOME RECENT ELECTRICAL PATENTS

Mercury Vapor Tube Electrical Repeater. The latest development of the now well-known Cooper Hewitt mercury vapor tube, as disclosed in a patent issued to the inventor, appears to be susceptible of an application of vast importance to the telephone industry. Mr. Hewitt has found that the resistance of his mercury vapor tube lamp may be varied by electromagnetic influence so that fluctuations in a circuit to which an electromagnet is connected may cause corresponding variations in the resistance of the lamp or tube. This effect is produced by arranging the electromagnet so that its flux must pass through the conducting vapor in the tube. Fig. 1 illustrates the elemental features of the invention; the magnet, 5, is supplied with current from a source, 1, and the current strength is varied by the device 4. The mercury vapor tube is connected in a circuit with a source of current, 8, and a receiving device, 9. The variations in current strength caused by the device 4 are reproduced in the receiver 9. It is scarcely necessary to point out that these two devices may be a telephone transmitter and a telephone receiver, so that the invention may find application as the long-sought telephone repeater to reproduce current fluctuations efficiently. Fig. 2 shows a modification in which the magnet is constructed with poles which embrace the vapor tube exactly as the field magnet poles of a dynamo embrace its armature. Patent No. 749,791.



FIGS. 1 AND 2.—ELECTRICAL REPEATER.

Quick Motion Switch. —Fig. 3 herewith illustrates an ingenious quick-motion switch mechanism devised and patented by W. F. Irish. The drawing, taken from the patent, shows the switch adapted for control by a tank float, but it may be applied otherwise, of course. The switch arm, *A*, is pivoted at *a*; the actuating lever *E* is pivoted to one arm of a bell crank *D*, which carries at the end of the other arm a weight, *K*. The downward pressure of the weight on the horizontal arm of the bell-crank forces the roller *e* against the arm *A* either below the pivot, as shown, or above it, according to the position of the lever *E*. With the parts in the position shown, when the float *F* descends far enough to carry the roller *e* above the pivot *a*, the weight *K* will force the lever *E* bodily to the left, and the latter will, of course, carry the arm *A* with it. As the roller *e* rises from its position shown in the drawing toward the pivot *a*, the lever *E* is pivoted to one arm of a bell-crank, *D*, away from the stop *b*, so that the weight *K* is free to act as described after the roller *e* passes the pivot *a*. Patent No. 751,174.

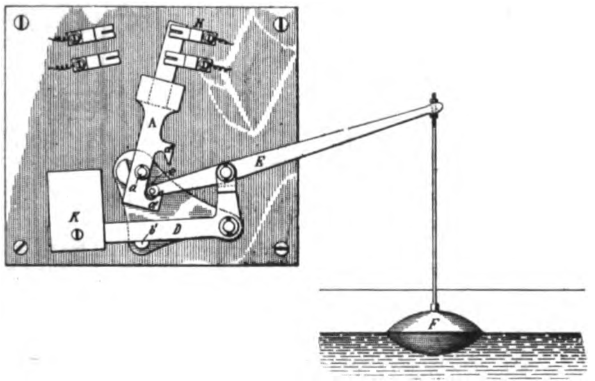


FIG. 3.—QUICK MOTION SWITCH.

Magnetic Clutch.—It is the custom in the construction of magnetic clutches to use two members of magnetic material, one of which carries a winding and therefore constitutes a magnet, and the other of which serves as an armature for the said magnet. This arrangement has the disadvantage, of course, that the coil must revolve when the magnet revolves, entailing the use of collector rings and brushes in order to lead the exciting current to the moving coil. Fig. 4 illustrates a form of clutch which has been devised by E. M. Hewlett in order to eliminate this feature. The clutch consists of a stationary member, *9*, of magnetic material, which carries the exciting coil, *11*, and is therefore the magnet of the system; two circular armatures, *6* and *6-a*, mounted on independent but co-axial shafts, *1* and *2*, and a friction surface, *7*. It is obvious that when the winding is excited, the discs *6* and *6-a* will be attracted by the magnet and also attract each other at the center. Whether both of them move axially or only one is a matter of constructional detail. Regardless of this point, the excitation of the coil obviously draws the two discs together, causing the friction surfaces to bind. Fig. 5 shows a modification of the arrangement, in which the air-gap between the revolving member *6-a* and the stationary member *9* is similar to that in a dynamo and is not altered by the axial movement of the revolving member. With this construction, presumably, the right-hand revolving member does not move axially. Patent No. 747,706.

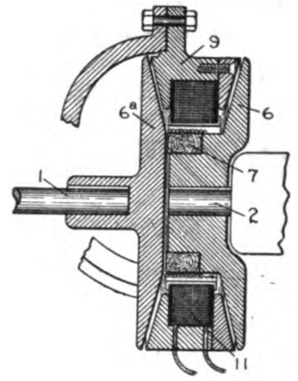


FIG. 4.—MAGNETIC CLUTCH.

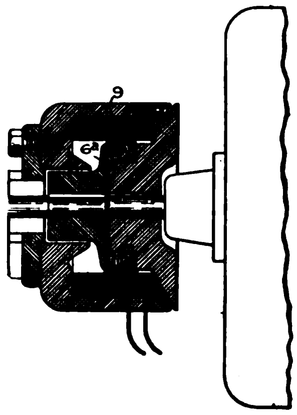


FIG. 5.—MAGNETIC CLUTCH.

◆◆◆

NOTES.

Machinery Dealers' Association.—The third annual convention of the Southern Supply and Machinery Dealers' Association will be held at Old Point Comfort, April 12 to 14 inclusive. The headquarters will be at the Hotel Chamberlain, and a very large attendance is expected. Special railway and hotel rates have been secured, particulars concerning which may be obtained from Mr. P. E. Blow, Knoxville, Tenn., president of the Association.

The Electrical Club Journal.—The first number of this publication appeared last month, and reflects much credit upon those responsible for it. The Journal is published by members of the Westinghouse Electric and Manufacturing Company's staff at Pittsburg, and its entire contents are contributed by the older engineers of the company. The particular object of the club is to promote fraternal relations between the younger engineers there, and the scope of the Journal is such as to make it of value to those men. It goes without saying, therefore, that the magazine is of a most useful character to young engineers in other manufacturing establishments or branches of electrical work.

Allis-Chalmers Company to Build Electrical Machinery.—This well-known manufacturer of steam engines and mining machinery has completed arrangements for entering the electrical field as a builder of generators and other apparatus. It is reported that this move is due to the fact that the General Electric Company, after perfecting the Curtis turbine, adapted it to the exclusion of reciprocating engines for large work, and declined to enter into an arrangement with the Allis-Chalmers Company for the building of the turbines in that company's shops. With the Westinghouse and General Electric Companies both building steam turbines the field for large Allis engines in this country has been reduced to slim proportions. Mr. John Kelly, who was for many years practically the chief engineer of the Stanley Electric Manufacturing Company, will be chief of the Allis-Chalmers electrical staff, and will have as an advisory associate Mr. William Stanley, Jr., the originator of the Stanley Company.

Wireless Telegraphy from Running Railway Trains.—Experiments recently made by Professor Biscan, Teplitz, Austria, with a view of using wireless telegraph apparatus from running railway trains, are said to have so far given quite satisfactory results, wireless dispatches being safely received and transmitted over distances as high as 7 km. from the station erected in Teplitz. The possibility of ensuring wireless communication with running railway trains has thus been evidenced. The car containing the apparatus was coupled to the back of the train, two wires leading outside of it. These wires were conveyed horizontally on both sides of the roof of this car and of three ordinary railway cars, terminating in a horizontal free point; they were intended to replace the antennæ otherwise used in connection with wireless telegraph stations to enforce the effects of electric waves. As soon as the train approached the Teplitz wireless telegraph station up to the distance above mentioned, whence a continuous supply of dispatches was to be given, the telegraph apparatus in the car would begin working, the paper ribbon containing the telegrams running off the roller in a manner quite analogous to an ordinary telegraphic apparatus. Similar experiments were carried out some time ago on the Berlin-Zossen military railway.

Mr. Dooley's Electrical Double Again.——The clever imitator of Mr. Finley Peter Dunne who occasionally writes for *The Electrical Times*, London, has broken out again and most amusingly, as follows:

DEPORTMENT FOR CONDUCTORS.

"Well," said Mr. Dooley, "I see be th' pa-apers that they're comin' along wid th' trams in West Ham, slowly but surely; there isn't so much as a thruck in th' pla-ace yit, but th' rules f'r th' conducthors is all finished an' will be advertised in a gazette extrayordinairy, be order iv th' council sittin' in conclave. Be th' time they've got th' conducthors th' trams will be ready. West Ham isn't a pla-ace f'r you and me, Hinnissy; they're too good f'r this wur-ruld iv sin an' sorrow; in th' nixt wur-ruld ye'll be able to tell which is a West Ham Councillor be his havin' no tail. Th' morals iv West Ham were threatened by th' elictric trams; th' soshulists an' passive resisthers was in da-anger iv contaminayshun be th' introducshun iv conducthors. Thin th' tramway committy stepped in. 'The council an' ratepayers are aware,' they says in their rayport, 'iv th' solicitood iv your committy f'r th' future state iv their souls, peace be wid thim. Your committy have given th' ingineer a motor-car f'r respectaybility; they've seen to th' dacency inside th' cars; an' now they've drawn up wan thousand two hundred an' fifty-fure rules f'r th' diportmint iv th' villainous conducthors.' Th' rules was inthroduced be Alderman Ikey in camera, because iv th' low-down doin's iv conducthors which was onfit f'r th' hearin' iv dacent folk; on'y th' councillors was prisint, an' th' sittin' was sustained an' prolonged. I'll tell ye a few iv th' rules, Hinnisy, which have leaked out be th' indiscreshuns iv councillors.

"'*Rule Sivin.*—Conducthors must not have button-holes. *Rule Sivin (a).*—If they've got them——'"

"I call that downright ondacent," said Mr. Hennessy; "phwat's to kape their trousis up, begob?"

"Divvle take ye f'r a red-nosed ould 'rangatang," cried Mr. Dooley, "who's tellin' this story, me or you, I'd like to knaw?"

"Gowan," said Mr. Hennessy, meekly. Mr. Dooley snorted once or twice and proceeded. "'*Rule twinty-one.*—Conducthors' clothes must be kept together be boults an' nuts. All nuts must be freshly polished every mornin' in a lathe provided f'r th' purpose. *Rule fifty-nine.*—If a nut wur-ruks loose, th' whole service must be sthopped whilst th' conducthor finds a spanner. *Rule wan hundred an' sivinty-five.*—Iv'ry conducthor to wear a watch an' chain, synchronised be Greenwich time. *Rule two hundred an' nine.*—No conducthor to wear a chain outside his coat, which must be bolted up tight. *Rule two hundred and ninety.*—Conducthors must stand wid their backs to th' dure to look f'r passengers comin' sideways. *Rule four hundred.*—Conducthors must keep their eyes on th' tram in front on penalty iv instant dismissal without a reason. *Rule four hundred an' six.*—Conducthors must keep their eyes on th' time an' see that th' driver——'"

"Hould on," said Mr. Hennessy; "he's got to be lookin' backwards, an' front, an' at his watch which is bolted inside his coat, all to onct. Phwat talk have ye?"

"The Council wants smart men," said Mr. Dooley. "*Rule sivin hundred an' thur-ruty* says 'conducthors' beards must be freshly trimmed each mornin' to angle iv thur-ruty degrees; dismissal f'r error iv more than five degrees. *Rule wan thousand an' fifteen.*—Conducthors wid no beards must be clean-shaved twice a day. No beards to be grown in th' Council's service. *Rule eleven hundred an' eighty.*—If a tram be smashed th' cost iv it will be sthopped fr'm th' conducthor's wages. *Rule elevin hundred an' ninety-sivin.*—Conducthors not to wear flowers in their button-holes. Only vegetables allowed. *Rule twelve hundred an' twinty-wan.*—Conducthors whin takin' fares fr'm young ladies to look th' other way. If ladies are there, conducthors must look at th' roof. *Rule twelve hundred an' twinty-nine.*—Any person wid dirthy clothes to be fur-rust disinficted be th' conducthor. If he rayfuses, th' conducthor may apply 500 volts, but quietly an' gently. If th' raysistance iv his skin is too great, th' conducthor may call th' polis, but th' traffic must not be sthopped.'

"That's a few iv th' rules," said Mr. Dooley, "an' they'll get a fine lot iv men. I dunnaw but phwat th' West Ham cars wont be travellin' chapels be th' time they're done, wid a altar at wan end an' houly wather as you go in be th' dure, not forgettin' th' collectin' box to buy insect powder f'r the seats. Th' conducthors will be houly men, an be th' time they understhand all th' rules they'll have grown wings. I see meself enterin' humbly th' sacrid veecle wid bowed head. 'How much, houly father?' I says. 'Th' fare is wan penny, my son,' says the conducthor, 'an' whativer else ye like to give to th' cause; we will now sing hymn wan hundred an' thur-ruty-sivin,' he says, switchin' on th' elictric organ under th' seats. As f'r th' women, I foresee throuble, Hinnissy. Think iv th' number iv gals wantin' to marry, an' a couple iv hundred smart an' handsome Saint Anthonys wid never a wink or a smile, rayfusin' to hilp th' ladies on an' off f'r fear iv th' future iv their souls."

"Phwat'll happen thin, avick?" asked Mr. Hennessy.

"It's difficult to say whin women is mixed up wid things," replied Mr. Dooley, "but I've heard that th' manager is inventin' an automatic conducthor. You put his wages in a slot once a week, an' he does his wor-ruk properly, not forgettin' th' chuckin' out. At th' end iv th' week you draw off his takin's, an' he never sthrikes."

"Merciful heavens!" exclaimed Mr. Hennessy.

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The Lamme Single-Phase Railway Motor.

The description of the Lamme single-phase alternating-current motor, which we print this month, will undoubtedly be read with the greatest interest by those who are at all concerned in electric traction, and we venture to predict that the simplicity of the method followed by the inventor to obtain practical commutation will be a surprise to most designing engineers. We do not refer to the constructional expedients of perforating the pole ends and using high-resistance commutator leads; the former is an obvious means of keeping down the field-magnet self-induction without entailing prohibitive armature reaction, and the latter is about twenty years old in direct-current designing. The development of the proper relation between the field counter e.m.f and the armature counter e.m.f and the determination of the numerical ratio between the two appear to be the most important features, so far as the English patent specification discloses the method of design. According to the figures given in the specification, if the ratio of field to armature ampere-turns be put at .625 then the relation between the field-induction (L), number of magnet poles (p), revolutions per second (s), counter e.m.f (e) generated in the armature winding, and the frequency (f) of the supply current in cycles per second reduces to

$$L p s = 2 e f.$$

It seems scarcely credible that such a complex problem is susceptible of so simple a solution.

Owing to a rather surprising obscurity of exposition in the patent specification, the inventor is made to say that the "self-induction" of the field-magnet is proportional to the frequency, number of turns of wire and magnetic flux, and in the second equation (on page 118 of this issue) that the counter e.m.f. of the armature (lap-wound) is proportional to the number of poles, as well as the number of armature turns and (by deduction) the magnetic flux per pole. Of course, both of these statements are incorrect and are probably not what the inventor intended to say. The term "self-induction" appears to have been used to express the idea of counter e.m.f. induced in the field windings by the alternating flux in the cores. In the preceding paragraph, therefore, an e.m.f. symbol should be substituted for the inductance symbol, L. We confess to have been unable to unravel the puzzle of the use of "poles" in the denominator of the fraction in the patent specification, notwithstanding the explanatory statement that "armature wires $= 2 \times$ poles $\times$ armature turns in series." This statement leaves the inference that the "armature ampere-turns" referred to throughout the specification are only those in series, but on the other hand, the ratio between field ampere-turns and armature ampere-turns is made one of the controlling factors, and it is not apparent that there should be any general relation between all of the field ampere-turns and the ampere-turns in series in the armature, independent of the number of poles; the relation would naturally be either between field ampere-turns *per pole* and armature series ampere-turns, or else between total field ampere-turns and total armature ampere-turns. As we are not expecting to design any Lamme motors, however, and Mr. Lamme's knowledge of elementary alternating-current mathematics and machine design is not in the least likely to be questioned by any sane person, we will leave those who are more vitally interested to struggle with the patent specification.

Referring again to the use of high-resistance leads from the armature winding to the commutator, it is as well, perhaps, to point out that the chief function of these is to keep down the current induced in the short-circuited coil by the alternations of the field flux, whereas in direct-current practice they were used to reduce the inductance of the short-circuited coil and incidentally to keep down the current induced in it by the cutting of lines of force due to the motion of the coil in the magnetic field. The ultimate object is the same in both cases, *i.e.*, proper commutation, but the need for such auxiliaries has been eliminated in direct-current practice by improvement in design. It is difficult to imagine what sort of refinement in the design of the series alternating-current motor can develop which will reduce the transformer effect in the armature winding sufficiently to obviate the use of some auxiliary means for preventing the induction of an abnormal current in the coils short-circuited by the brushes during commutation, and as Mr. Lamme's expedient is about the simplest that will serve the purpose it will probably be permanent so far as simple series motors are concerned.

The conclusions to be drawn from the reasoning given in the English patent specification are that the new series motor will necessarily be somewhat heavier than the direct-current machine of the same class, since it is impracticable to magnetize the field-magnet material to anything like the same degree; that the full-speed efficiency should be fully as high as that of the direct-current motor, and the efficiency at intermediate speeds and during acceleration considerably higher, since speed control may be effected by means of transformers instead of dead resistances; and that the torque characteristic of the alternating-current machine will be better than that of its direct-current rival of equal rating for the reason that the field-magnet iron *must* be worked at low degrees of magnetization at normal speeds, so that there is more flux per field ampere-turn. If the direct-current machine were allowed the same weight, however, so that lower magnetic densitites would be practicable, it would doubtless show better torque characteristics than the series alternating-current motor. Furthermore, the higher efficiency of the alternating-current machine is to some extent offset by its low power factor when starting up and while running at slow speeds and the existence of a fractional power factor at higher speeds. And, within the ordinary working range of practice, it is evident that the power factor and output per unit of weight tend in opposite directions; that is, the higher the power factor, the heavier will be the motor.

Wireless Telegraphy.

We are really beginning to despair of ever seeing the fruition of even the most modest ambitions of wireless telegraph enthusiasts. At the outset we mildly suggested that wireless telegraphy might prove of incalculable practical value for signalling between ships and lighthouses, shore stations, etc., over relatively short distances, but that its field was obviously limited, and we were promptly put down as belonging in the category of pessimists and obstructionists. Time has developed numerous "inventors" of wireless systems, produced magnificent fields for all such systems—on paper—and brought forth inspiring recitals of "intentions," claims, predictions, etc., *ad infinitum*. But we have been pained to note that whenever anyone has called upon wireless telegraph apparatus actually to do something practical and fulfill one hundredth of one per cent of the roseate promises made for it, something "unexpected" has happened. The legitimate market for operative wireless apparatus has never been satisfactorily supplied; the United States Signal Corps has had a succession of discouraging experiences with wireless telegraph apparatus and promoters; attempts at practical wireless operation on an important scale made in this country have turned out exasperating fizzles. Under the circumstances we acknowledge that the first clause of our original prognosis was wrong and are tempted to substitute the opinion that wireless telegraphy shows no symptoms of proving valuable under any industrial circumstances whatever. This, however, would scarcely be justified, since there are a few ship and shore stations at work.

Fan Motors for This Season.

It will be evident to readers of our annual fan-motor article in this number that the limit of improvement in the construction of these machines has been about reached. All of the changes since last year are in minor details and have been made in order to add to the convenience of the user rather than to increase the efficiency and reliability of the apparatus, the maximum of these two characteristics having been already obtained. A notable development in the line of fan motors, however, is in the provision of means for diffusing the air currents produced by the fans. The oscillating, revolving, or otherwise restless motor has become an accepted type, and the number of machines of this class is rapidly increasing. For the general cooling of rooms of moderate size, they are undoubtedly advantageous, while the older type of motor giving a direct stream of air is probably best suited for individual service. All of them, however, are extremely meritorious little machines, and we have no intention of making any invidious comparisons; each type has advantages over the other under certain conditions.

Machine Tool Motors.

In the interests of the manufacturers of electric motors it is to be hoped that the application of these highly useful machines to the driving of machine tools will not be abused or carried to extremes that will prove boomerangs, as has occurred in other lines of electrical work. Nothing reacts more disastrously upon the advocate of any engineering practice than the discovery by "parties of the second part" that the practice is not justified or that the methods involved have been applied injudiciously. We hasten to interpolate the statement that we strongly advocate the use of electric motors wherever sound engineering principles require or allow it. It is not often, however, that individual motor drive is economical in very small units; it is also frequently inadvisable to obtain variable speed by means of complex systems of supply. Both of these two methods have their fields, of course, and they are by no means small ones; but neither method can be indiscriminately applied without ultimately bringing motor drive into disrepute as to fulfilling all of the promises made for it.

The feature of variable speed in machine-tool motors appears to have been carried to excess in some instances. The users of such tools have been apparently content for years with six, or at most eight, speed rates; it would appear, therefore, somewhat unnecessary to increase the number by two or three hundred per cent. in a single jump. The machine-tool man would probably have been delighted with ten or a dozen speeds and never have thought of demanding any more if a few well-meaning builders had not voluntarily offered them as an inducement. Of late, it may be said, the tendency is strongly toward limiting the number of speeds to a rational value, such as twelve, but it is extremely difficult to undo an error in policy which favors the other man unwarrantably.

It is not practicable to discuss here fully the several methods of obtaining variable motor speed in their relation to economy. A book could be written on the subject. The method of supplying current at three or more different fundamental voltages which can be combined in different ways has, of course, the merit of reducing the motor itself to the simplest possible construction and also involves less variation in field-magnet strength for a given number of running speeds than either the simple three-wire distribution with equal voltages on both sides of the neutral wire or the two-commutator motor used on a two-wire circuit. The double-commutator machine has, on the other hand, the great advantage of being workable on any simple two-wire circuit, and will give double the range in speeds on a three-wire circuit that a single-commutator motor will give with the same arrangement of field gradation. It seems clear to us, viewing the matter impartially, that the choice between multiple voltages and multiple motor armature windings depends to a great extent upon the magnitude of the plant. For a very large factory or works, where first cost is not of so much relative importance and where the establishment can afford to employ thoroughly competent men to look after the electrical apparatus, a multivoltage system giving not over four fundamental voltages would probably be preferable in most cases; under other conditions the double-commutator machine appears to have the advantage, generally speaking.

A HOME-MADE SENSITIVE MIRROR GALVANOMETER.

BY JOHN D. ADAMS.

The galvanometer here described is of the mirror or reflecting type, and in common with instruments of this class, is intended to be used with a suitable source of light and a screen or scale. The design is such that the instrument can be readily constructed by any one familiar with experimental work. Fig. 1 is a front elevation of the galvanometer, Fig. 2 a vertical section through the center and at right angles to the view in Fig. 1, and the remaining illustrations are details.

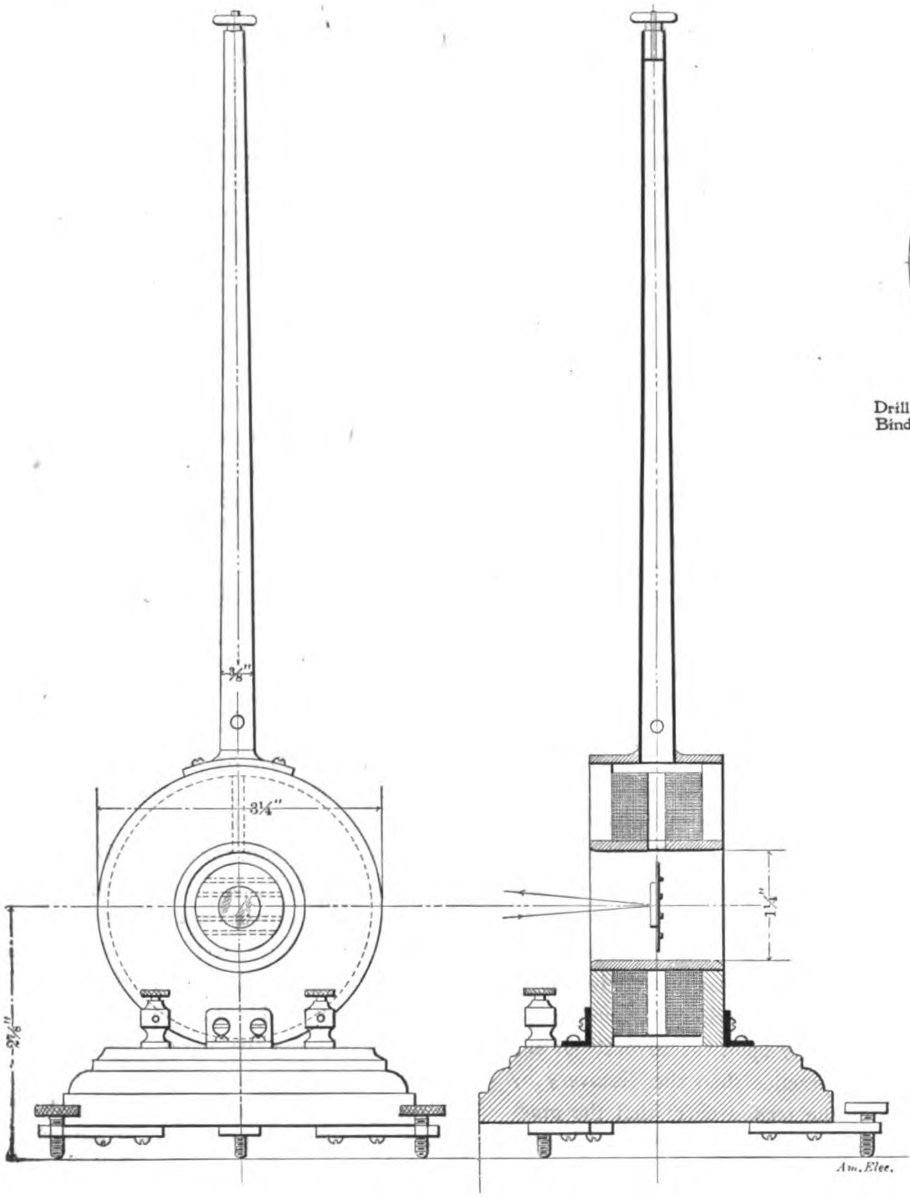


FIG. 1.—ELEVATION AND VERTICAL SECTION OF GALVANOMETER.—FIG. 2.

The base, Fig. 3, is made preferably of hard wood, such as walnut or cherry, and of the dimensions specified in the sketch. Upon this is mounted a spool containing the winding; the spool is secured to the base by means of two angle pieces and eight small wood screws (of brass). The core of the spool is best made of a piece of fibre tubing, but it can be made by winding a strip of tough shellacked paper 1⅝ inches wide around a 1¼-inch mandrel until the paper is ⅛ inch thick. Before starting to wind the paper tube, a layer or two of oiled paper should be wrapped around the mandrel to prevent sticking. After the tube has been built up to the required thickness of wall, it must be allowed to dry hard before being handled; if facilities are available, it should be baked out slowly in an oven at a temperature of about 100° Fahrenheit. When hard, the end should be trimmed off smooth and accurately at right angles to the bore of the tube, and a square hole, 3-16 inch square, cut through one side exactly midway of its length and with its axis precisely radial to the axis of the tube.

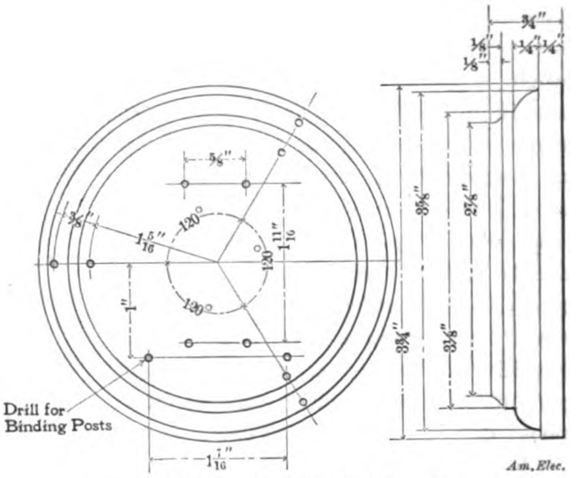


FIG. 3.—PLAN AND ELEVATION OF BASE.

The bobbin or spool heads are made of the same material as the base unless hard rubber is available for the purpose, in which event it should be used. If the heads are of wood, they must be glued on securely. A good method is to lay one head on a flat true surface, cover one end of the core tube with glue, and insert it in the hole in the head, pressing the end of the tube fairly down on the flat surface under the head so that it touches that surface uniformly all around. Then put on the middle disc which serves as a partition between the two halves of the winding. This is 3 inches in diameter and 3-16 inch thick; the hole in its center must fit very snugly over the outside of the tube. A radial slot 3-16 inch wide is cut from the periphery of this partition disc to the central hole, as indicated by the dotted lines in the left-hand part of Fig. 4, which shows the complete spool or bobbin. The purpose of this slot is to allow the suspension thread which holds the mirror to pass. In order to guard against interference with the suspension thread by any stray fibres of insulation on the wires of the winding it will be advisable to paste a disc of tough bond paper on each side of the partition disc so as to cover the radial slot and convert it into a rectangular channel. The other head disc is then put on in the same way as described above, and the partition disc is then centered between the two heads and fastened in position by a few drops of glue at the core. After the glue has set, all surplus glue should be removed, and the screw holes drilled in the heads for the screws which hold the bobbin to the base and those which hold the suspension-tube socket at the opposite edges of the head discs. The mouth of the core tube should be chamfered out into a bell-shape, as indicated in Fig. 4, so as to give a greater range of swing to the beam of reflected light.

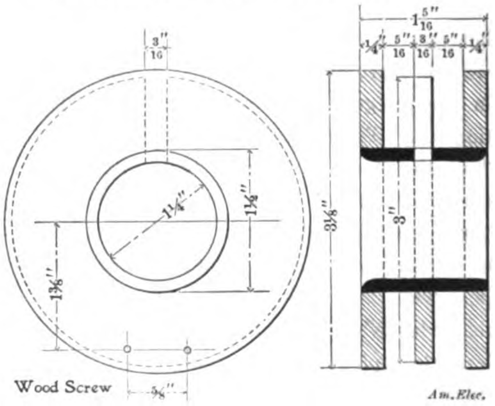


FIG. 4.—PLAN AND SECTIONAL ELEVATION OF BOBBIN.

Each compartment of the bobbin is wound with No. 30 or 32 double-silk-covered wire; single-cotton-covered wire may be used, so far as insulation is concerned, but silk-covered wire is better because more turns can be put in the available space. In beginning the winding, the inside end of each half should be led out through a small hole in the head disc of that half. The two halves must be wound in opposite directions; that is, after winding one half, the bobbin must be turned around, end for end, and the other half wound in its compartment by running the lathe in the same direction as before. The outer ends of the two halves are connected together over the edge of the partition disc, preferably about midway between the top of the bobbin or spool and the base. A protecting strip of thin imitation leather 13-16 inch wide and 9⅝ inches long might then be wound over the wire, giving the spool the appearance of having only one coil. The glued joint in this strip should come at the under side of the spool, and a 3-16-inch square hole should be cut in the center to coincide with the opening in the center disc.

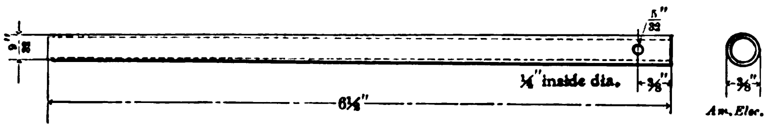


FIG. 5.—DETAILS OF SUSPENSION TUBE.

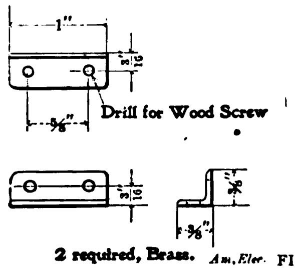


FIG. 6.—BOBBIN BRACES.

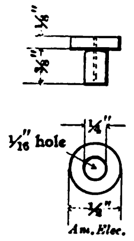


FIG. 7.—SUSPENSION TUBE PLUG.

The spool is placed centrally upon the base and attached thereto by means of the two angle pieces, as shown. These angles are bent from a piece of strip brass 1 inch long and ⅜ inch on each side. Round-head brass screws are used here, making countersinking of holes in the angle pieces unnecessary. After the spool is secured to the base in this manner a piece of 1-16-inch brass, 1⅜ x 1 5-16 inches with a ⅜-inch hole in the center, should be bent to the curve of the spool head edges and fastened thereto by means of four round-head brass screws. This is the socket for the suspension tube. The latter is a piece of heavy ⅜-inch brass tubing 6½ inches long, filed tapering and polished in the lathe. At a point ⅜ inch from the larger end a 5-32-inch drill is run through, and then a second time at right angles to the first. These holes are for the purpose of observing the silk fibre in order to see that it hangs perfectly clear. Before putting on the leveling screws, the base should be set on a flat horizontal surface and the suspension placed in the socket on top of the spool and soldered fast in a vertical position. A little wooden plug is fitted snugly into the end of the tube, with a 1-16-inch hole bored lengthwise through it. Through this small hole the silk fibre passes, and after the approximate length of the fibre is determined, it is held fast by a little piece of wood forced in the hole. To adjust the magnetized needles to such a height that they will hang in the exact center of the paper tube, the plug is moved bodily up or down in the top of the brass suspension tube. The fit of this plug should be such that it can be readily moved yet have sufficient friction to hold it in position; or else a smooth-nose set-screw must be provided to hold it wherever it may be set.

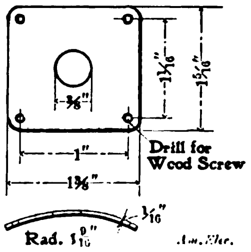
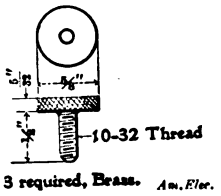


FIG. 8.—SUSPENSION TUBE SOCKET.

On the back of a circular piece of cardboard about the thickness of a visiting card and 1⅛ inches in diameter are fastened by means of shellac 5 small pieces of magnetized cambric sewing needles, and on the other side a small piece of ordinary mirror glass. Of course, a small concave mirror would throw a more clearly defined spot of light on the screen, and this should be used if obtainable; but the ordinary glass will serve very well if the scale is kept well shaded. It is well not to magnetize the needles until after they are fastened in position on the back of the card, as they are then less likely to have the magnetism jarred out of them or to be placed on the card with opposite poles pointing in the same direction. The card acts very well as a damper in bringing the needles to rest. The needle disc should be suspended by a fibre of cocoon silk if the maker can obtain it; if not, a piece of ordinary fine sewing silk may be untwisted and one fibre taken out; in order to straighten this, it should be moistened and hung up by one end with a little weight at the other and allowed to dry. One end of the fibre is attached by shellac to the cardboard disc, and the other end fished up through the brass tube and made secure in the wooden plug at the top, as described before.

On the under side of the base three radial lines should be drawn 120° apart and two holes drilled on each line at the points indicated, to receive the screws for holding the leveling lugs. On the upper side of the base the four holes for the small wood screws of the angle feet are drilled, and two holes must be drilled clear through for binding-post screws. The leveling is done by means of three screws threaded into the three projecting brass lugs, set 120° apart on the under side of the base. These lugs are made from 3-16 x ½-inch. flat brass, two holes being drilled and countersunk in each piece for the wood screws and one hole tapped for a 10-32 machine screw. Rounding the projecting ends of these lugs to ¼-inch radius is advisable. The leveling screws may be turned from ⅝-inch brass rod and should have knurled and rounded noses or ends. The thread is 10-32 and the shank ½ inch long.

The instrument built by the writer was placed on the end of a long table lying east and west and the leveling screws adjusted until the silk fibre was seen, through the holes in the base of the tube, to be hanging perfectly free. The source of illumination, which was placed on the opposite end of the table, consisted of an ordinary kerosene lamp set in a soap box standing on end with its bottom facing the galvanometer. A hole ¾ inch in diameter was bored through the bottom of the box at such a height that the light coming through would strike the mirror. A 1-inch board about 4 feet long and 6 inches wide was then nailed on the bottom of the box, parallel to the table and below the light hole, to serve as a scale. The soap box kept the light from the scale quite satisfactorily.



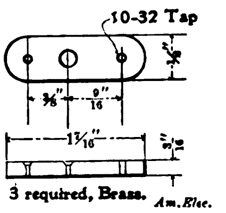


FIG. 9.—LEVELING SCREW AND LUG.—FIG. 10.

The apparatus set up in this manner would readily detect the current generated by touching the points of a brass pin and steel needle to a drop of salt water. In order to make the position of the instrument independent of the earth's magnetism, a small magnetized bar about 3-16 x 4 inches was placed across the brass tube and made adjustable as to height. It is hardly necessary to add that no iron screws should be used in the construction.

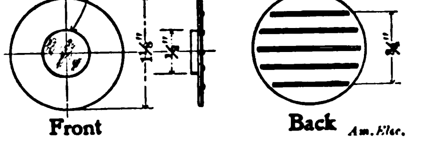


FIG. 11.—FRONT, SIDE AND REAR VIEWS, SHOWING ARRANGEMENT OF MIRROR AND MAGNETS.

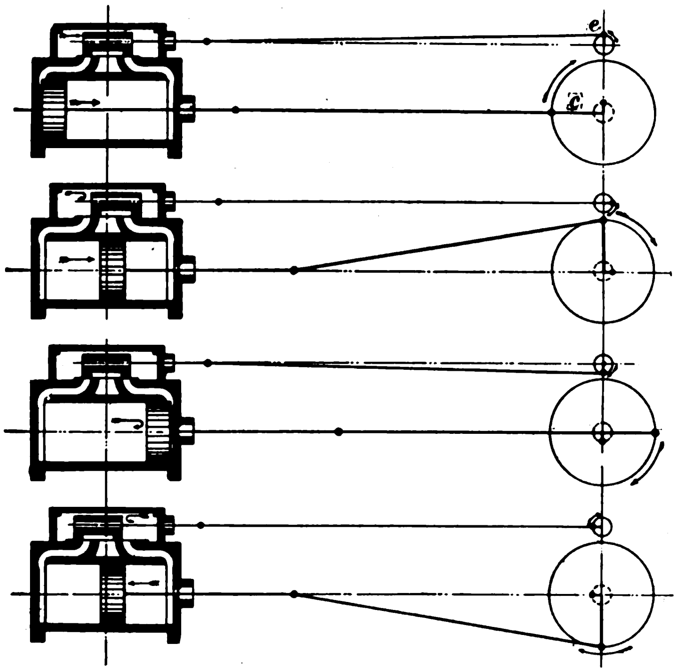
VALVE GEARS.

BY C. C. MAJOR.

Relation Between Piston and Valve Position and Crank and Eccentric Angles.

"Slide vale" is a term usually applied to flat-faced valves having a reciprocating motion in a straight line, although special valves as piston valves, Corliss valves and others having cylindrical surfaces are virtually slide valves. Fig. 3 shows a section through a plain D slide valve and ports of an engine. The valve is shown in its central position. The portion, *s*, extending beyond the outside edge of the port is the steam lap, and that portion, *e*, beyond the inside edge is the exhaust lap.

One of the most important points in the study of valves and methods of setting them correctly, is to thoroughly understand the relations existing between the linear positions of the valve and piston, and the corresponding angular positions of the crank and eccentric. In order to bring out more clearly the object or purpose of steam and exhaust-lap of a valve, the relative positions of the various parts will first be shown when the valve has no lap and just covers the steam ports.



FIGS. 4, 5, 6 AND 7.

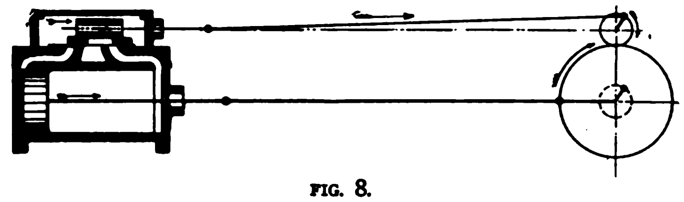


FIG. 8.

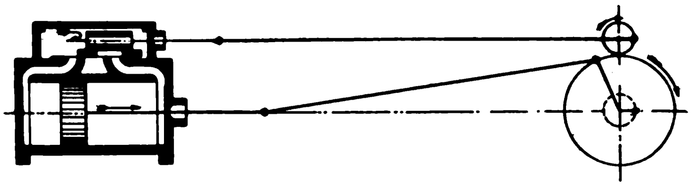


FIG. 9.

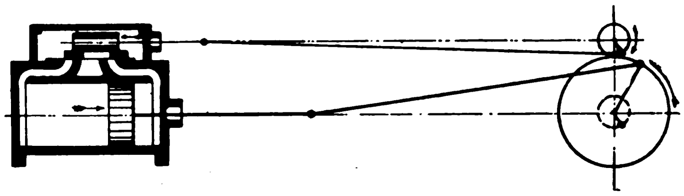


FIG. 10.

In Fig. 4, the valve is in its central position covering the ports. The piston is at the end of its travel, the crank, *c*, is on the dead-center nearest the cylinder and the eccentric is at *e*, just 90° ahead of the crank. The angularity of the eccentric-rod would change the angle between the crank and eccentric but very little, as the rod is quite long as compared to the throw of the eccentric, so its effect may be neglected. The shaft is supposed to turn in the direction indicated by the arrows and when the eccentric has reached its dead-center farthest from the cylinder as shown in Fig. 5, the valve has opened the port wide and any further movement of the eccentric will begin to close the ports. The crank has passed through one-fourth of its revolution and the piston has traveled a little more than half its stroke.

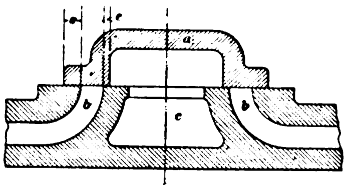


FIG 3.

As the eccentric moves past the dead-center, the valve is returning to its central position. Fig. 6 shows the crank on the dead-center farthest from the cylinder, when the piston has completed its stroke, and the valve has closed the admission port, cutting off the supply of steam. From this figure it is evident that the admission port is open until the piston has traveled its entire stroke and when the exhaust valve opens, which will occur as soon as the valve moves past its central position, the steam will be exhausted at the same pressure as the entering steam, that is, high pressure steam has followed the piston during its entire stroke and the expansive force of the steam has not been utilized. This is, of course, a very wasteful method of working, but is used in most of the small steam pumps and accounts for the large amount of steam required for their operation, which may vary from seventy-five to one hundred and fifty pounds per horse-power per hour.

Fig. 7 shows the eccentric on the dead-center nearest the cylinder; the valve has opened the opposite port wide. The piston is in the same position as shown in Fig. 5 and has the greater portion of its stroke yet to travel. When an entire revolution has been completed and the crank has reached the dead-center, the same condition exists as shown in Fig. 4.

In order that the admission port may be closed early in the stroke to utilize the expansive force of the steam, the outside edge of the valve is extended; that is, steam-lap is added, and the more lap, the earlier in the stroke will the admission of steam be cut off. Inside or exhaust-lap is added to cause the exhaust-port to open later in the stroke and to close earlier on the return stroke.

Figs. 8 to 12 show several relative positions of the valve, piston, eccentric, and crank, for a valve having both steam and exhaust-lap. The eccentric has been turned on the shaft to bring the outside edge of the valve a little beyond the edge of the port when the crank is on the dead-center nearest the cylinder and the piston is at the head end of its travel, as in Fig. 8. The distance that the valve is open when the crank is on the dead-center is the "lead." When a valve has lead, the steam port is opened and the cylinder clearance spaces filled with high-pressure steam before the piston begins its return stroke. This steam forms a cushion for the piston and helps to bring the moving parts to rest without jar or shock. When the eccentric has reached its dead-center farthest from the cylinder, as shown in Fig. 9, the head-end port is open wide and any further movement of the eccentric will begin to close the port. The valve will continue to move to the left and when it has reached the position shown in Fig. 10, the steam port will be closed; the position then occupied in the cylinder by the piston is the point of cut-off with the arrangement here shown; the piston has traveled about three-fourths of its stroke when the valve cuts off. From this position to that shown in Fig. 12 the piston will move under the expansive force only of the steam.

In Fig. 11 the inside edge of the valve

has just closed the port, thus preventing a further escape of exhaust steam. As the exhaust steam in front of the piston can not get out, it will be compressed into the clearance space, the pressure gradually rising and presenting an increasing resistance to the movement of the piston. This resistance or pressure of compression helps to bring the moving parts gradually to rest as the piston approaches the end of its travel. This position of the piston at the instant of exhaust closure is called the "point of compression."

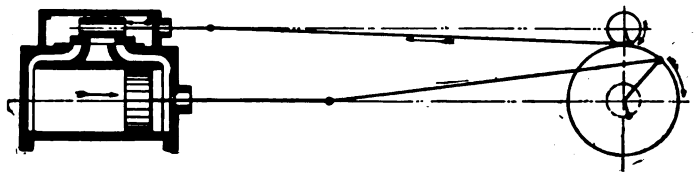


FIG. 11.

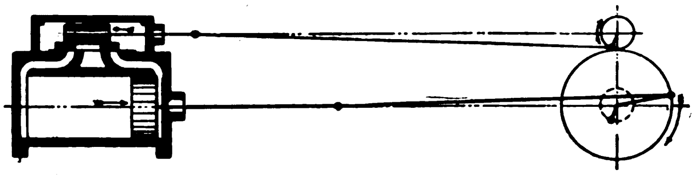


FIG. 12.

Fig. 12 shows the valve about to open the port leading to the space behind the piston. This is the "point of release" and should occur when the piston has nearly reached the end of its stroke. The object of having the exhaust port open behind the piston is to secure a wide opening of the port early in the return stroke.

Setting a Slide Valve.

In setting a plain slide vale, the first step is to place the engine on the center.

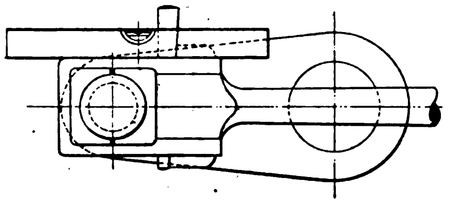


FIG. 13.

If the strap on the end of the connecting-rod is quite long and its upper surface parallel to the axis of the rod, a spirit-level may be used as shown in Fig. 13. When the air bubble is in the highest part of the glass and is exactly bisected by the line midway on the glass, the centers of the crank-pin and shaft are in the same horizontal plane and the crank is on the center. A more common method is turn the engine shaft in the direction it is to run until the crank is nearly horizontal. A straight edge is held against one end of the cross-head and the position of the cross-head marked on the guides. The mark may be more easily seen and need not scratch the metal if a piece of chalk is first rubbed on where the mark is to be made. While the crank is in this position, a center-punch mark is made on the frame in some convenient place to take one end of a bent scriber (see Fig. 14). With the other end, a line is drawn across the edge of the rim of the fly-wheel. The crank is then turned past the center until the cross-head reaches its former position and another line is drawn across the fly-wheel. The distance between these two lines is bisected and a center-punch mark made to locate permanently this point. The shaft is then turned until the center-punch mark is true with the scriber point; in this position it is on the center. The scriber shown by Fig. 14 is easily made and serves the purpose admirably. It may be made of ⅛-inch steel wire or 3-16 to ¼-inch round or flat iron. The ends are tapered and sharpened to fit a light center-punch mark.

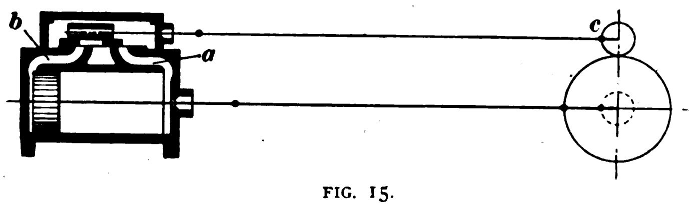


FIG. 15.

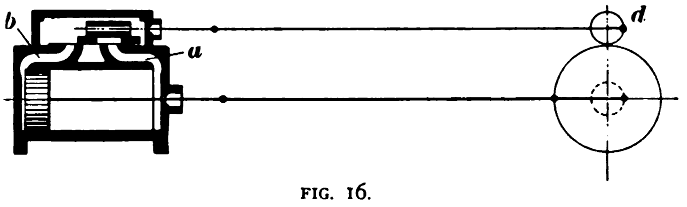


FIG. 16.

After putting the engine on the center, the valve is set about midway on the stem so that it (the valve) may move freely the required distance without danger of having the end of the valve-stem strike the wall of the steam chest. The valve should travel equal distances each side of the central position. To determine whether or not the valve has equal travel on each side of the center, the eccentric is turned on the shaft until it is on the center nearest the cylinder, as shown at *c*, Fig. 15. If the eccentric-rod is too short, the valve will not move far enough to the left and the crank-end steam port, *a*, will not be fully opened for the admission of steam. If the valve has over-travel, the port may be opened wide, but the length of time the ports are opened will not be the same for both ends. When the valve is in this position, the eccentric has to turn through only a slight angle to cause the valve to move far enough to cut off the admission of steam; consequently, an early cut-off occurs in the crank-end of the cylinder.

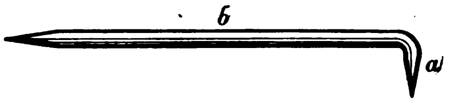


FIG. 14.

When the eccentric is turned to the opposite center, farthest from the cylinder, as at *d*, Fig. 16, the steam edge of the valve will move beyond the edge of the port *b*. As the valve has farther to travel in order to close the steam port, cut-off will occur later than it should, and a greater amount of work may be done in the head-end than in the crank-end; furthermore, the angular velocity of the fly-wheel will vary considerably during each revolution.

To adjust the length of the eccentric-rod, the eccentric is turned to the center nearest the cylinder and the rod lengthened until the edge of the valve is in line with the inner edge of the port; then the eccentric is turned to the opposite center to see if the same condition is obtained. If the valve has over-travel or is designed so as not to fully open the port, the eccentric-rod is adjusted to give the same amount of over-travel or port opening at each end when the eccentric is on the center.

After the eccentric-rod has been adjusted it is necessary to set the eccentric to give proper steam distribution. If the crank is on the center nearest the cylinder, the piston is at the head-end of the cylinder, of course. The eccentric should be turned around the shaft in the direction in which the engine is to run until the port leading to the head-end of the cylinder is open from 1-32 to 1-16 of an inch, according to the amount of lead desired; then fasten the eccentric to the shaft and set the crank on the opposite center and note if the lead is the same. The lead should be the same, but if there is only a slight difference, the valve may be moved on the stem to take up half the difference in the lead. If there is considerable difference for the two positions, part of this difference may be adjusted by moving the valve on the valve stem and part by moving the eccentric.

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INTERCOMMUNICATING TELEPHONE SYSTEMS.

The Samson Junior.

BY A. DALLAM O'BRIEN.

In previous articles a number of intercommunicating telephone systems have been described, in which the salient feature has been the automatic switch, whereby at the expiration of a conversation the instrument is returned to its normal condition. The automatic feature, while unquestionably a good one, need not necessarily be present in a system of this kind, and it is the purpose of this article to describe a type of telephone suitable for installation in all cases where intercommunication is required and which does not depend for its action upon the automatic return of the selective switch to its normal condition. The system described herein is capable of a number of modifications to suit various requirements of service and of wiring, and the absence of the automatic features enables the instrument itself to be contained in a small space.

The type of telephone shown in Fig. 1 is intended for non-selective private lines; the act of signalling from any telephone connected to the line rings the bells of all the instruments connected to the system. Thus it follows that an installation of this character is applicable principally in cases where it is desired to communicate with a number of stations at once, and where the absence of the selective feature is not an inconvenience.

In a large number of instances the selective feature is absolutely essential and for this purpose the instrument shown in Fig. 2 is designed. A push button is supplied for each station, and the depression of the button serves to signal the desired instrument. The internal arrangement of this type, which is shown in Fig. 3, is such that it is possible for only two stations to be connected at one time without interference; in order to provide for a number of simultaneous connections the instrument shown in Fig. 4 is supplied.

The general system of wiring used with all these instruments, except the first type, consists in connecting the various stations with a cable containing one wire for each instrument and additional battery wires, the number depending upon the class of installation; that is, whether local batteries are used at each station to furnish talking current, or whether a central battery is used to furnish current for all the stations connected to the system. With the class of instrument shown in Fig. 1 considerably less wiring is required than with the other types, as in this case it is only necessary to run four wires throughout the system and connect each station thereto. One wire is used to furnish current for signalling, one for the common return, one for the bells, and one to supply current to the transmitters through a retardation coil. The effect of this method is to bridge the battery across the talking wires and to connect the transmitters and receivers at the various stations in series and bridge them across the battery leads. The bells are also connected in multiple, so that a signal from one station rings at all stations. The same battery is used for both ringing and talking purposes. As this method of wiring is so simple and is used so extensively with private lines, it is hardly necessary to describe it further.

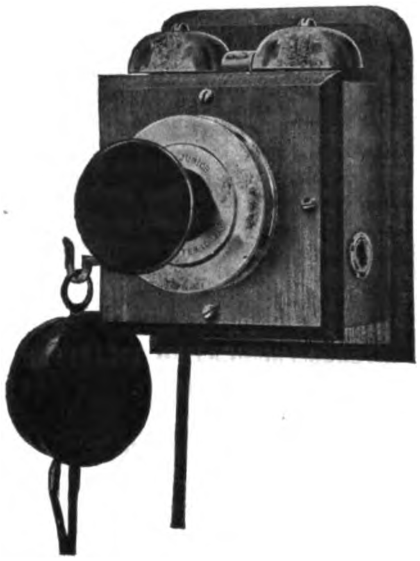

FIG. 1.

The desirability, if not the necessity, of a selective system of signalling in a private telephone installation usually leads to its general adoption, and the methods of wiring for such a system are shown in Figs. 5 and 6. The diagram in Fig. 5 shows an installation of three stations of the type illustrated in Fig. 4, connected so as to use a central ringing and a central talking battery. One wire from each station is run throughout and connected to a contact stud at each other station. Three additional wires are run throughout the system, one carrying talking current, the second ringing current, and the third acting as a common return for both the talking and ringing currents.

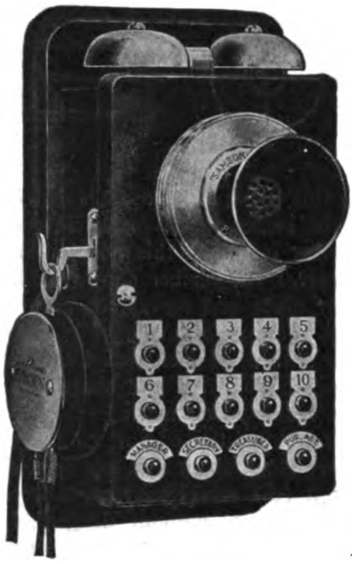

FIG. 2.

The hook switch at each instrument does not in itself act as a conductor, but carries four contact springs which serve to close the proper circuits. The bells are connected, as shown, to the home point of their respective instruments, and when the receiver is on the hook, through a contact spring to the common return. One side of the push button is connected to the switch lever, the other side carrying ringing current from the central battery. The transmitters are connected directly to the talking battery and are wired each in series with the primary winding of an induction coil, their local circuits to the battery being closed through the hook switch contacts and the common return when the receiver is removed from the hook. The secondary, or receiver circuit, is connected to the switch lever, and through the contact springs on the hook switch to the common return.

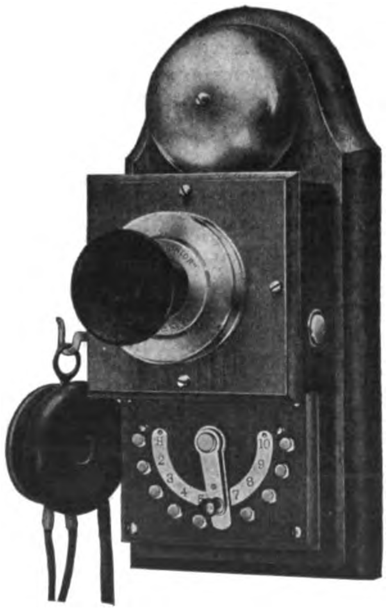

FIG. 4.

In order to signal any desired station, the switch lever is moved to the proper contact stud; to No. 2, for example, as shown at Station I in the diagram. The push buttons is then depressed and current flows from the ringing battery through the switch lever and contact stud at Station I, over line 2, through the bell at Station II, and thence through the contact springs at the hook switch at Station II, back to the ringing battery over the common return, thus signalling the station. The receivers being removed from the hook, the ringing circuit is opened and the talking battery circuit is closed through the transmitter and primary of the induction coil. At the same time, the secondaries and receivers at the connected stations are connected in a closed circuit through the line of the called instrument, the switch levers, the hook switch contact springs, and the common return wire.

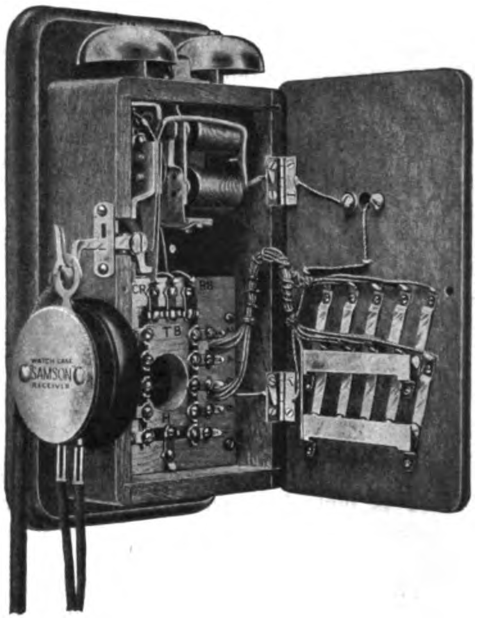

FIG. 3.

From this description it will be seen that the transmitters are furnished with current very much in the same way as are the operators' transmitters in a central office; in other words, they are connected in multiple across the leads from the talking battery. The difficulties arising from interference during simultaneous connections will depend upon the resistance of the battery leads and the internal resistance of the battery, but in general with a system of this kind the possibility of interference is negligible and simultaneous connections may be considered entirely feasible.

The diagram in Fig. 6 shows the arrangement of circuits when a central battery is used for furnishing ringing current and where local batteries are used at each instrument for furnishing the talking current. In this case, as will be seen from the diagram, one less wire is required throughout the system, and at the same time, the chances of interference are considerably reduced. The method of operation for this class of wiring does not differ from that of the central energy method, and the same description applies, the only difference between the two systems being the manner in which the battery current is furnished to the transmitters. The instruments are furnished, as a rule, with the type of watch-case receiver illustrated in the cuts, although when preferred they are equipped with the usual form of hand telephone. The transmitter is adjustable and has a movement of 25 degrees above and 16 degrees below the horizontal, the conducting cords being carried inside the transmitter mounting and connected in such a way that the frame of the transmitter is insulated from the circuit and does not act as a conductor.

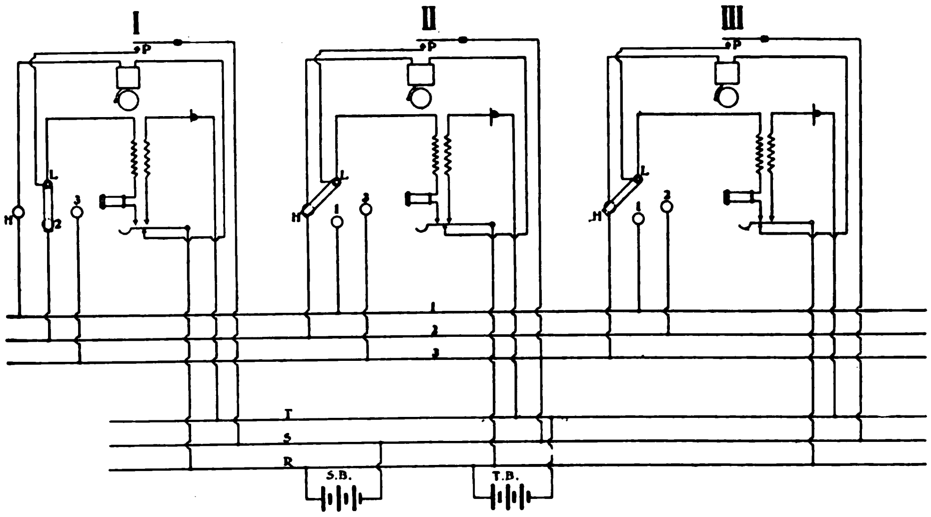

FIG. 5.—DIAGRAM OF CONNECTIONS FOR A THREE STATION SELECTIVE TELEPHONE SYSTEM.

The instruments are arranged for either exposed or concealed wiring, as desired, the case being designed for the style of wiring which it is proposed to use. In the exposed style of wiring the cable is fastened to the wall at the desired height and taps are made sufficiently long to serve as connections. The cover carrying the transmitter and switch block is removed, the telephone attached to the wall and the wiring brought in through a hole in the back board. This board is made of 1-inch wood and is grooved ⅝ inch deep, the groove serving to carry the cable. A hole 3¼ inches in diameter is cut through the back, the taps from the cable brought in and attached to the switch block in the instrument. The local wires to the instrument proper are connected within the case. Where it is desirable to use concealed wiring, the cable or taps therefrom are brought into the instrument through a hole in the back and connected to an internal switch block. The interior arrangement of these instruments is well shown in Fig. 3, the switch block, hook switch, local connections and push button strip being clearly illustrated. The push button centre is supported on the outside of the case by an escutcheon plate, the inside contact consisting of a long German silver spring; the number of each push is stamped on its supporting plate. The springs all make contact on a metal strip of sufficiently heavy gauge to have elasticity enough to produce a good rubbing contact. In this type of instrument, as has been previously pointed out, it is not possible for more than one pair to converse at a time.

With the switch arm type, illustrated in Fig. 4, a natural tendency to bend the arm when operating it is avoided by the addition of the extra arm which is fastened to the switch arm proper. The bells used for signalling purposes are equipped with double gongs mounted on a one-piece bracket, by means of which they are kept the proper distance apart. The hammer ball is covered by a formed punching held rigidly in place by the gong bracket and thus preventing any tampering with the hammer.

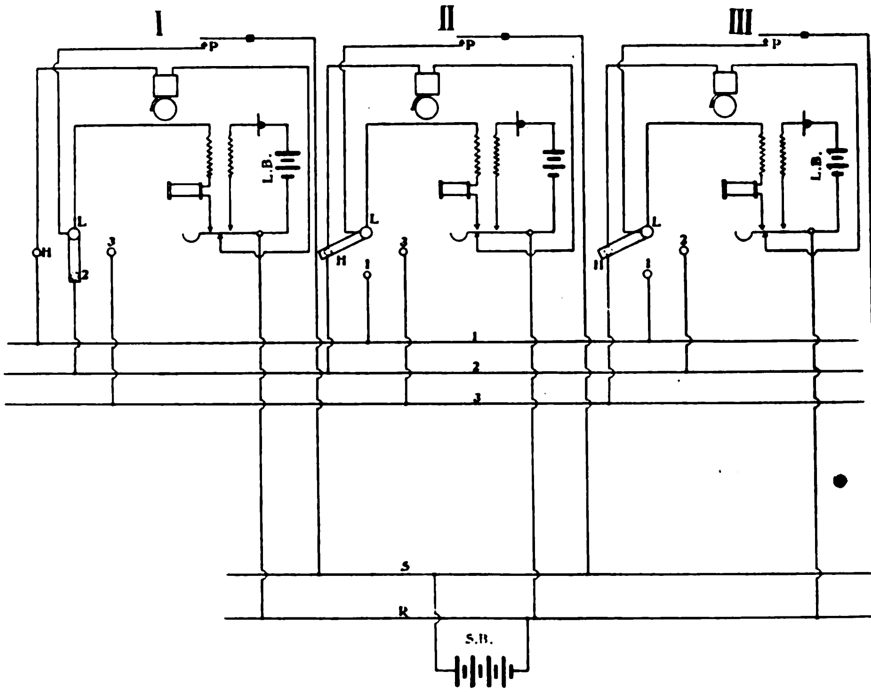

FIG. 6.—DIAGRAM OF CONNECTIONS WITH A CENTRAL SIGNALLING BATTERY AND LOCAL BATTERIES FOR TALKING CIRCUITS.

The induction coil is mounted in the interior of the instrument, and is equipped with a special connector for the receiver cord terminals. The compact arrangement of these instruments will be readily appreciated from the fact that the instrument shown in Fig. 1 is contained in a case 3⅞ inches by 4 inches, while the type shown in Fig. 2, having an equipment for six stations, is contained in a case 5¼ inches wide, 8¼ inches high and 2⅝ inches deep.

If desirable, desk telephones can be furnished for use with the systems described, the wires to the instrument being first terminated on a switch block, and the local wiring to the transmitter being made from the block through the medium of an instrument cord. With the common-battery desk set, the induction coil is mounted in the base of the stand, while with the local battery method of installation the induction coil is contained in the switch block. The push button strip, or strip containing the switch arm and contact studs, may be mounted at any desired point near the instrument.

In the common-battery type of installation, probably four cells of any good wet or dry battery will answer for furnishing the talking current, and four or five cells will be sufficient for ringing power. Where local batteries are used for talking purposes, two cells at each instrument will be sufficient, the common ringing battery consisting of four or five cells, according to the distance over which it is necessary to signal. With the switch-arm type of instrument, the signalling push button is mounted on the side of the case, as shown in Fig. 4, and with this type either the central battery or local battery system can be used without making any change in the internal wiring of the instruments.

The number of instruments that can be

connected to a system, using the type shown in Fig. 1, is limited only by practical operating conditions, while the other two types are equipped for any number up to 20 stations. The telephones described herein are manufactured and handled by the Electric Gas Lighting Company, of Boston, Mass.

NOTES ON INTERIOR WIRING.

BY ARTHUR B. WEEKS.

In Fig. 1 is shown a typical panelboard. Sixteen circuits radiate from this board; these circuits were run in open work, using cleats and circular loom, in the building where the photograph was taken. The ceiling is unfinished, so that wherever rosettes are located, a small strip of wood is nailed on the side of the joist to provide the proper bearing. Often pieces of pine are set in between joists for rosettes and porcelain cleats, depending upon the location desired for the light.

Where the wires come into the panelboard from above, it is not only neater but essential that they should be run in moulding, since so many wires could not be accommodated on the post in cleat work. Where the many circuits distribute above the panelboard on the ceiling, it gives a very neat appearance to use matched ceiling for several feet, to allow for the proper distribution of circuits. The moulding can also be cut to give a symmetrical appearance where several mouldings are placed side by side. Let the center form the apex of an obtuse triangle, and slope both sides down at the same angle. Also arrange the cleats symmetrically. The same regard for appearance should be observed in making connections from the moulding to the panelboard; flexible conduit should be used continuously from the moulding to the board. The wires back of the panelboard should not be crossed if it is possible to avoid it.

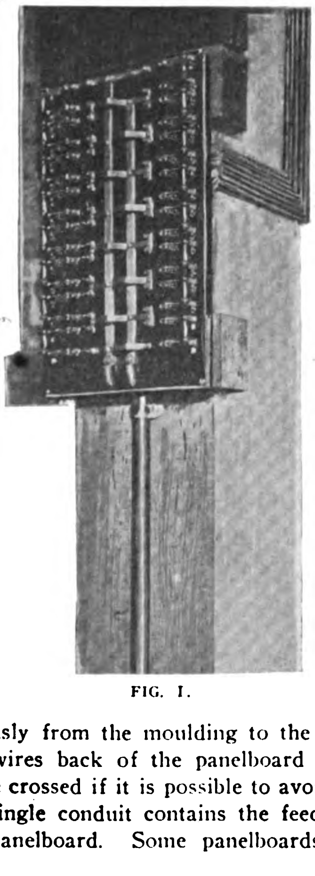

FIG. 1.

A single conduit contains the feeder for this panelboard. Some panelboards have continuous bus-bar connections; that is, there are connections at the top ends of the bus-bars for a feeder to the floors above. Fig. 2 illustrates such a case of wiring; in this illustration the panelboard is not in place. It will be noticed that two-wire mouldings is run from the panelboard to a point within a few inches of the ceiling, where the several circuits branch out in flexible conduit which is continuous from the end of the moulding to the porcelain cleats; this practice should always be followed in such cases.

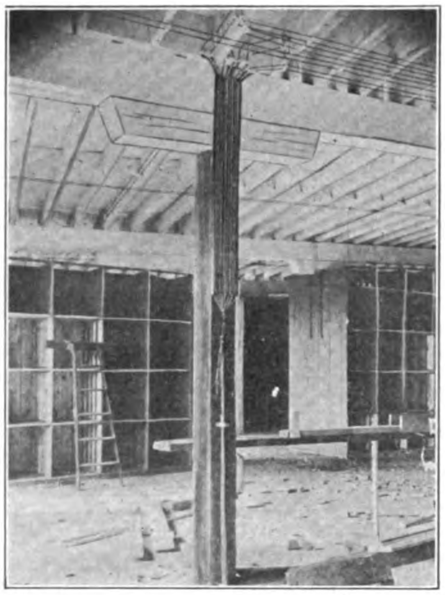

FIG. 2.

It is necessary to set the panelboard out from the post to clear the conduit, and to allow sufficient clearance for inserting the wires after the board is in place. Pieces of 2 x 4 scantling are nailed to the post for a bearing at each corner, and the panelboard is secured by screws to these blocks. If the posts are to be encased, the spacing blocks to which the panelboard is secured must be set out from the post according to local conditions. Fig. 3 shows such a panelboard in position. In all such cases, the carpenter should be consulted.

By taking advantage of the early stages of construction work in buildings, it is possible materially to cheapen the electric work. For example, when a circuit is to be run to light a stairway bricked up on all sides, and an iron plate is to be put into the floor at the doorway and after filled in with concrete, porcelain tubes can be put in on the ceiling level below and afterward be bricked over, then the job completed with iron plate, brick and concrete. This saves drilling holes through the walls by means of a hammer and a piece of gas pipe.

Where doorways are cut through old stone walls, sometimes three feet through, while the masons have the stones torn out preparatory to inserting a lintel over the doorway, have them cut a little more if necessary to insert iron pipes of the proper size, so that porcelain tubes can be inserted in the ends of the pipes after the stonework is all completed and the door hung. If a sliding door is to be used, care should be taken not to get the holes so low that the runway for the door will interfere with the tubes; otherwise, it will be necessary to drill new holes. Again, if workmen of other trades are still carrying on their work after holes have been drilled in the walls for wiring, pipes should be inserted in such holes to indicate beyond possibility of mistake their location and purpose; otherwise, plumbers will in all probability run pipes directly across the path of the leads and necessitate much extra work.

Plans are sometimes changed so that a partition comes in direct line with a baseboard receptacle. If the baseboard is not yet in place, and it is necessary to provide an outlet within a few feet of its originally contemplated location, and a change in conduit is impossible, an outlet box adapted for circular loom work can be placed where desired and loom can be run from the conduit box to the other box and a "blind" cover be put on the conduit box.

It is a good plan to find the true level of the floors before locating any baseboard or post receptacle boxes. Considerable electric work sometimes has to be changed because the receptacles have been put up in accordance with the baseboard ground and afterward some of them had to be raised several inches, or else the worse expedient of dipping the floor had to be adopted.

Before placing receptacles on posts, one should see the carpenter's plans to be sure of getting the right height for the receptacles, lest they come on the moulding on some posts and no two posts be alike. First of all, the floor line should be ascertained. When conduit is run vertically on posts which are to be encased the conduit should be no larger than absolutely necessary in any case, and put as close as possible to the posts. Should "headers" prevent a straight run, they should be altered.

To run conduit from an unfinished room to a ceiling fixture in a hall which is plastered, a ceiling outlet should be located in the hall at the proper depth and, after drilling through the wall, an outlet box should be placed in the adjoining room at the ceiling; the conduit is run from one box

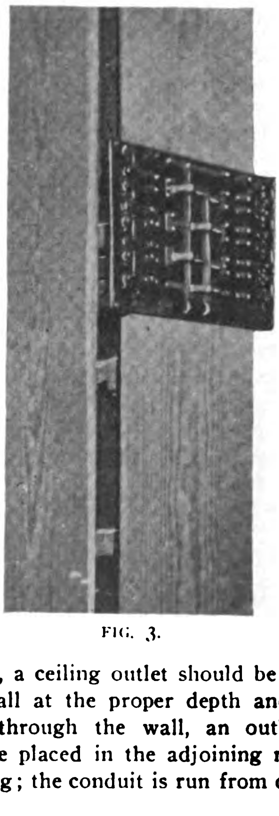

FIG. 3.

to the other, the wire pulled in the conduit, and a blind cover put on the box in the room. Put circular loom over the wire from the last box to the first cleat, and drop down in moulding to a switch if so desired.

One of the things to be ascertained before stringing wire for open work in any room is whether or not the room is to be whitewashed. If so, that work should be completed before running the circuits. Inspectors do not like to pass work when the cleats, rosettes, etc., are spattered with whitewash.

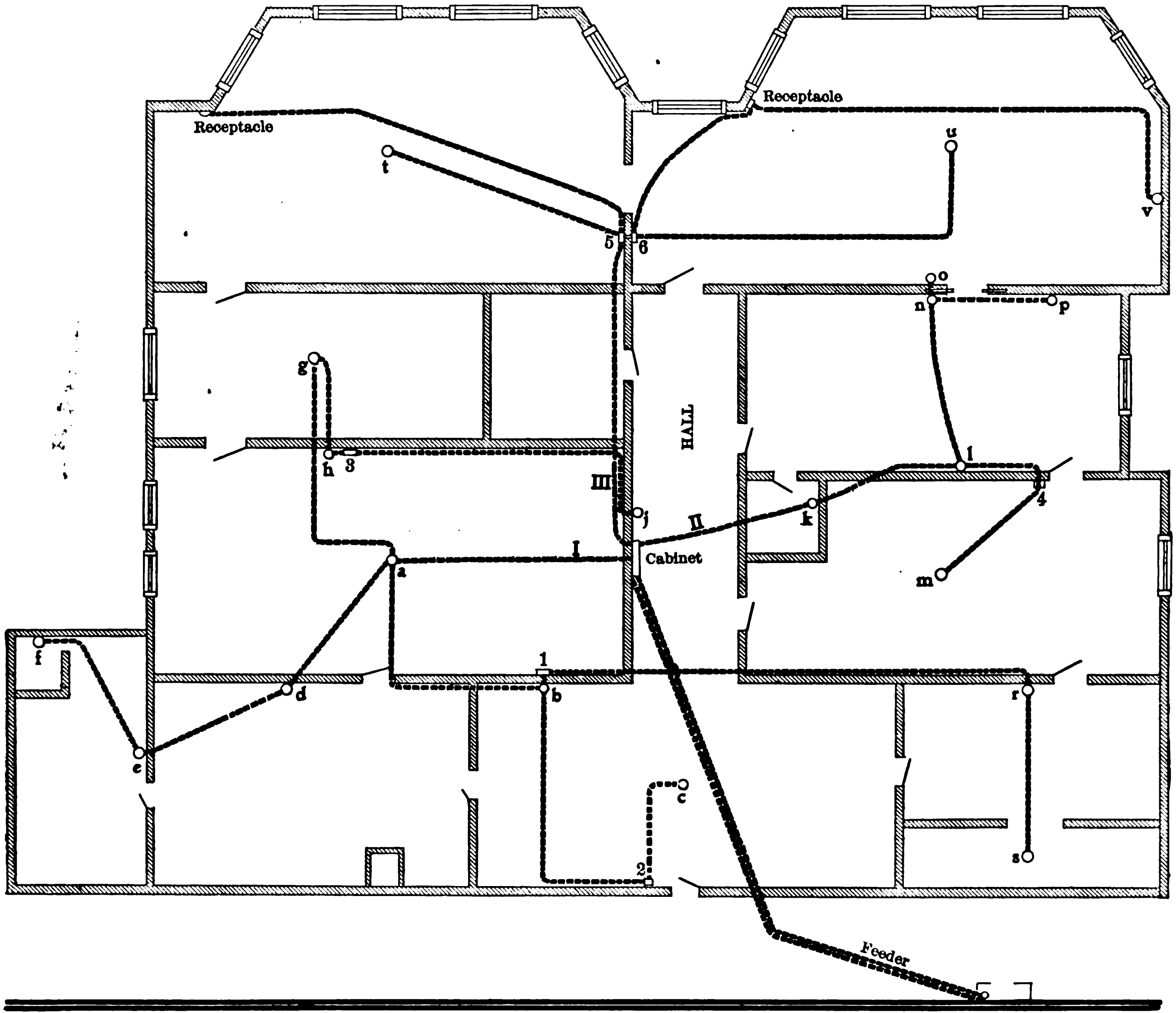

FIG. 4.—WIRING DIAGRAM FOR APARTMENT REQUIRING TWENTY-THREE LIGHTS.

Fig. 4 is the plan of a suite of rooms in an apartment block wired in conduit. The building is of steel construction; all side walls, ceilings and floors are furred. Outlets are indicated by circles and switches by squares. The total number of lights is twenty-three. A ¾-inch iron conduit runs from an outside hall center of distribution; No. 12 feeder wire is used. The distribution circuits are of No. 14 duplex rubber-core wire. The three-wire system is employed throughout the building, but only one side is tapped for this suite. The cabinet is located in the most convenient place, which happens also to be practically at the center of distribution.

Fig. 5 indicates the construction of the cabinet box in which the slate panel is located. All dimensions are plainly marked. A "ground" ⅜ x ¾-inch is nailed on the studs which form two sides of the cabinet, while the other two sides of the cabinet extend out even with the side grounds. The parts *A* and *B* are first nailed together, then *C* and *D*, and these are then inserted between vertical scantlings. The top and bottom walls, *A* and *D*, are brought out flush with the grounds *E* and *F*, which are nailed in place first of all. All parts should be securely nailed. In this case the holes for the conduit were at the top, in the wall *A*. These holes are, of course, bored before the parts are put in place.

Following the circuits, *I* starts from the cabinet, extends up to the next floor, and over on the rough floor to outlet box *a*; here there are three branches. This box is located centrally and secured in place on the joists or furring strips, according to the construction. The feeder enters this box at one of the top holes in order not to cross pipes, but not by the center hole, which is reserved for a fixture plug. From *a*, a branch feeder runs to the floor above, crossed over by the shortest path and drops to a side wall bracket at *b*; the switch *1* in the adjoining room would, of course, be lower than the bracket *b*. The switch box is mounted on a piece of flooring nailed between the studding, and conduit connects *b* with this switch, which controls the outlets *r* and *s*. From *b*, conduit runs down between the studding, out at the floor, and up to the switch *2* which controls the outlet *c* on the ceiling. From this switch box the conduit runs up above the furring strips for the ceiling and enters a side hole in the outlet box *c*.

The second branch from *a* runs over on the rough floor above and drops to the bracket outlet *d*, whence it runs down, over, and up to *e*; thence down to the floor, over again, and up to the outlet *f*. The third branch leaves the box *a* by a top hole, runs along on the floor above, and enters the box *g*, from which the line comes back on the floor above and drops to the bracket *h*. From here, conduit goes to the switch *3* and thence across by the nearest way to the hall lamp *j* near the cabinet. This completes one circuit of ten lamps. Circuit *II* is similar in character to circuit *I*.

Circuit *III* goes from the cabinet up to the floor above and down to the switch outlet box *5*. From here it runs back to the floor above and over to the ceiling outlet *t*. The adjoining switch-boxes *5* and *6* are connected by means of a nipple, since both are on the same piece of ⅞-inch board secured at the center of a studding. From the switch-box *5*, a branch drops down and crosses over on the rough floor to the baseboard receptacle. From the other switch-box, *6*, one branch runs to a baseboard receptacle and continues over to the side bracket lamp *v;* another branch runs to the ceiling outlet *u*, which can be reached by running the conduit just above the furring strips.

Wherever gas pipes have to be crossed on the floor, the floor should be cut out and the conduit dropped with a slight bend beneath the gas pipe.

If any changes are made in the course of conduit running, the wireman should not fail to mark them on the blueprint.

When installing conduit, always take the shortest course possible. Some of the lines shown on the accompanying drawing do not indicate the shortest distance from point to point, as they would intersect other lines and be misleading.

If for any reason changes are made so that the covers of baseboard receptacles or of switches are set deeper in plaster than was intended, longer screws can be procured, and by means of leather washers the parts can be built out and the cover put on in the proper vertical plane.

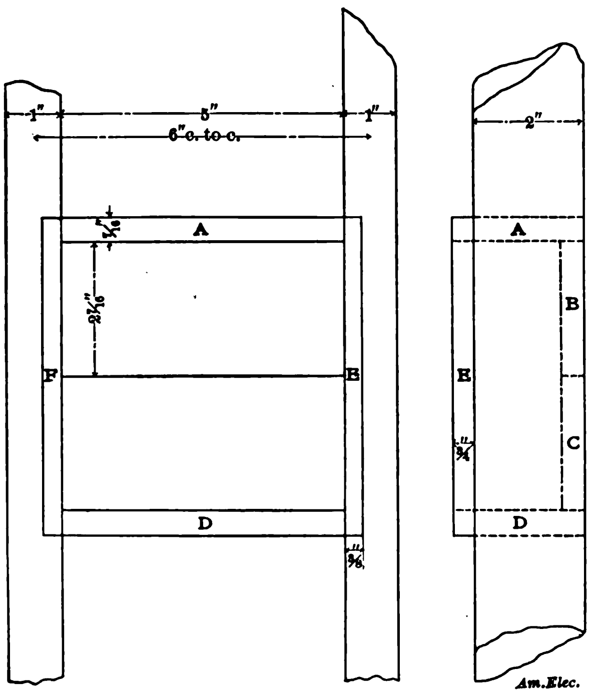

FIG. 5.—FRONT AND SIDE VIEWS OF CABINET BOX.

Lessons in Practical Electricity

ALTERNATING-CURRENT CIRCUITS—POWER FACTOR.

When several inductive devices are connected in series on an alternating-current circuit the total impedance of the group cannot be ascertained by adding the individual impedances arithmetically, as is done with resistance; the impedance of each device must be resolved into its component resistance and reactance, the individual resistances added to find the total resistance, the individual reactances added to find the total reactance, and the total resistance and reactance combined geometrically to find the total impedance. Referring to Fig. 1, for example, *a*, *b* and *c* represent two inductive and one non-inductive devices, the coils *a* and *c* being the inductive parts of the circuit. The resistance, reactance and impedance of each is inscribed on the diagram; the non-inductive device, *b*, has no reactance, of course, so that its impedance is equal to its resistance. The arithmetical sum of the three impedances is obviously 10.619; the correct sum, or total impedance of the group is

$$Z = \sqrt{(R_a + R_b + R_c)^2 + (X_a + X_c)^2},$$

The sum of the resistances is 6.555, the square of which is 42.97; the sum of the reactances is 6.167, the square of which is 38.03; the sum of these squares is 81, and the square root of 81 is 9. The total impedance, therefore, is 9 ohms.

When inductive apparatus is connected in parallel, which is the most frequent method in practice, the joint impedance of any given group of devices is ascertained by a similar method to that just described; but instead of considering individual resistances and reactances, the opposite properties of *conductance* and *susceptance* are considered. In direct-current work, it may be remembered, conductance is the reciprocal of resistance; in alternating-current work, the actual conductance of an inductive circuit is not taken, but a value which might be termed the effective conductance is substituted. The effective conductance is that value which is obtained by dividing the current by the e.m.f. and multiplying the result by the cosine of the "angle of lag." The quotient obtained by the division of the amperes by the applied volts is termed "admittance" of the circuit or device. The relation between admittance, effective conductance and susceptance is precisely the same as that between impedance, resistance and reactance, explained in the last Lesson. Fig. 2 is the triangle showing these relations; the symbols for the three properties are given on the diagram. The formula for admittance is therefore the same as that for impedance, if conductance be substituted for resistance and susceptance for reactance; thus:

$$Y = \sqrt{G^2 + K^2}.$$

Fig. 3 represents five pieces of apparatus connected in four parallel circuits; the individual resistances and reactances are inscribed on the diagram as before. Since the current, e.m.f. and angle of lag are not given, the individual conductances (effective) and susceptances must be derived some other way. The effective conductance of an inductive device is given by the formula

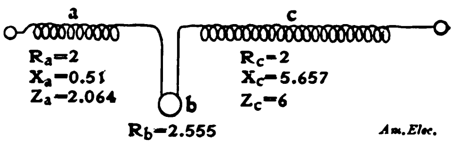

FIG. 1.

$$G = \frac{R}{R^2 + X^2},$$

and its susceptance by the formula

$$K = \frac{X}{R^2 + X^2}.$$

The coil *a* has a resistance of 100 ohms and a reactance of 40 ohms; its effective conductance, therefore, is

$$\frac{100}{10000 + 1600} = .00862,$$

and its susceptance is

$$\frac{40}{10000 + 1600} = .003448.$$

The total resistance of the lamp *b* and coil *c* is 240 ohms, and the total reactance is 60 ohms, *b* having no reactance. The effective conductance of the two, therefore, is

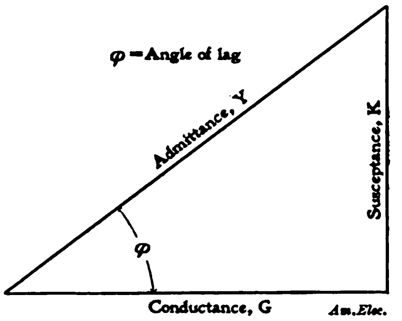

FIG. 2.

$$\frac{240}{57600 + 3600} = .003922,$$

while the susceptance is

$$\frac{60}{57600 + 3600} = .0009804.$$

Since the lamp *d* is non-inductive, its effective conductance is equal to its actual conductance, *i. e.*, the reciprocal of its resistance. The susceptance and effective conductance of *e* are determined in exactly the same way as those of *a*, of course.

The sum of all the conductances is .025234 and the sum of the susceptances is .0095566;

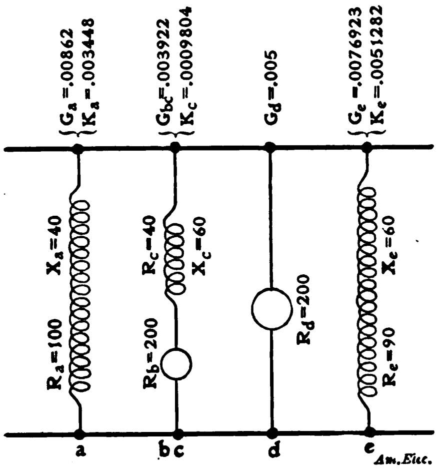

FIG. 3.

according to the admittance formula the total admittance, therefore, is .02698, and as impedance is the reciprocal of admittance, the joint impedance of the group is 37 ohms.

The following list of the relations between e.m.f., current, resistance, reactance, impedance, effective conductance, susceptance, admittance and functions of the angle of lag will be found useful::

$$Z = E \div I = \sqrt{R^2 + X^2} = R \div \cos \phi$$

$$X = \sqrt{Z^2 - R^2} = \sqrt{\left(\frac{E}{I}\right)^2 - R^2} = Z \sin \phi = R \tan \phi$$

$$Y = I \div E = \sqrt{G^2 + K^2} = G \div \cos \phi$$

$$K = \sqrt{Y^2 - G^2} = \sqrt{\left(\frac{I}{E}\right)^2 - G^2} = Y \sin \phi = G \tan \phi = \frac{X}{R^2 + X^2}$$

$$G = \sqrt{Y^2 - K^2} = \sqrt{\left(\frac{I}{E}\right)^2 - K^2} = Y \cos \phi = Z \cos \phi = \frac{R}{R^2 + X^2}$$

$$\begin{aligned} \cos \phi &= R \div Z \\ &= I R \div E \\ &= G \div Y \\ \sin \phi &= X \div Z \\ &= K \div Y \\ &= I X \div E \\ \tan \phi &= X \div R \\ &= K \div G \end{aligned}$$

In direct-current circuits, the power delivered to any circuit is the product of the applied or impressed e.m.f. and the current that flows; thus,

$$P = E I,$$

P being the power in watts. This is true also in an alternating-current circuit when there is no inductance nor condensance* present. This condition, however, is seldom realized in alternating-current work. In most cases the current is out of phase with the impressed e.m.f., and then the power in the circuit is equal to

$$P = E I \cos \phi.$$

ϕ being the angle between the two lines representing the e.m.f. and current relations, as before. Since this formula differs from the direct-current formula only in the addition of the expression "*cos* ϕ" and as multiplying the apparent power, $E \times I$, by it gives the true power, it is commonly referred to as the "power factor" of the circuit; sometimes it is represented by the symbol *p*, but most writers use the expression "*cos* ϕ."

The relation between the e.m.f. and current "phases" may be more clearly grasped, perhaps, by drawing sine curves representing any convenient values of e.m.f. and current out of phase to any extent less than one-quarter of a cycle and plotting the vectors corresponding to these curves. Thus, assume an e.m.f. of some conventional value and draw a half sine wave of such height that the distance from the base line to the crest of the wave will be 1.4 times the length of a straight line representing, to a convenient scale, the effective e.m.f. assumed. Then draw another half wave bearing the same relation to a current value either slightly greater or slightly less numerically than the chosen e.m.f. value, and displaced from the e.m.f. wave horizontally. Now draw a vertical line from the base line up to the crest of the e.m.f wave, as shown in Fig. 4; this will represent the maximum e.m.f. to the scale originally selected in plotting the curve. Duplicate this line on another part of the paper, as shown by Fig. 5; set the points of a pair of pencil dividers on the base line and the crest of the current curve in Fig. 4, and with them draw the arc shown in Fig. 6 from the vertical e.m.f. line to the base line. Then locate on this arc a point that is the same height distance above the base line as the intersetion *x* in Fig. 4; this may be readily done by drawing a line parallel with the base line at the same height as the intersection *x*, and cutting across the arc with it, as shown at *y*, *z*, Fig. 7. From the intersection *x* draw a line to the bottom of the vertical e.m.f. line, as shown in this last sketch; this will represent the magnitude and phase of the current as compared with those of the e.m.f. represented by the vertical line. Obliterating the construction lines leaves the diagram as in Fig. 8; the angle ϕ between the e.m.f. and current lines is the angle of lag, and the cosine of this angle will be the power factor of a circuit in which the maximum e.m.f. and current values are those assumed and in which the current lags behind the e.m.f. to the extent represented by the curves of Fig. 4. It should always be borne in mind by the student, however, that both the e.m.f. and the current have no actual direction in space; it is customary to refer to the angle of lag as though it were an actual angle between two forces which have actual and different directions, but this is merely a mathematical fiction employed for convenience in making calculations.

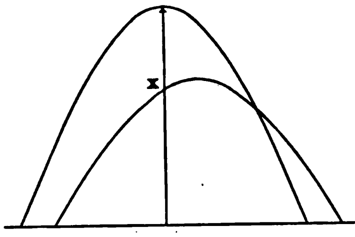

FIG. 4.

FIG. 5.

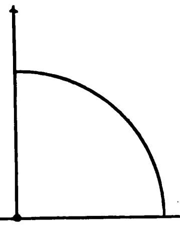

FIG. 6.

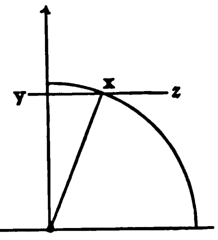

FIG. 7.

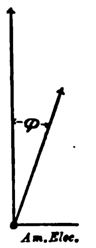

FIG. 8.

The sine of the angle of lag is termed the "inductance factor," for the reason that if it be multiplied by the impressed e.m.f. the result will be the inductive e.m.f., or e.m.f. due to the self-induction of the circuit. It (the inductance factor) is commonly represented by the letter *q*. Thus

$$E q = E_x,$$

E_x representing the inductive, or reactive, e.m.f., as explained in the last Lesson. Since E_x is also equal to the product of current and reactance $I X$, when X represents the reactance of the whole circuit, $E q = I X$.

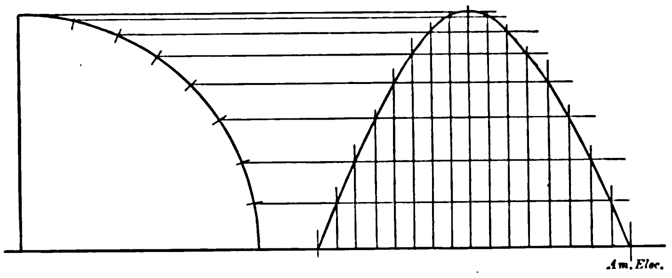

FIG. 9.—CONSTRUCTION OF A SINE CURVE.

A sine curve is constructed as follows: Draw a base line, and from it carry a perpendicular line up to the height corresponding to the maximum value (1.4 times the effective value) of the e.m.f. or current to be represented. From the top of the vertical line, draw a circular arc down to the base line; divide this arc into eight equal spaces by little cross lines and draw horizontal lines from the intersections of these cross lines and the arc, parallel with the base line. Then draw 15 equidistant vertical lines from the base line across the horizontal lines just completed; the doubly consecutive intersections of the horizontal and vertical lines will be points on a half sine wave. See Fig. 9.

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*This term will be explained in a future Lesson.

Letters on Practical Subjects

Mr. Ellison's Problem in Broken Wires.

To the Editor, American Electrician:

The accompanying diagram (Fig. 1.) is submitted as a solution of Mr. Ellison's broken wire problem which appeared in the January number. The method of locating the break is the ordinary application of the Wheatstone bridge, making one of the line wires from the home station to the break the unknown resistance and assuming the resistance of the ground at the far end to be negligible. On this basis the resistance of the line wire will be

$$R = \frac{A\ B}{C};$$

and knowing the resistance per mile or per thousand feet of the wire, the distance is of course readily ascertainable.

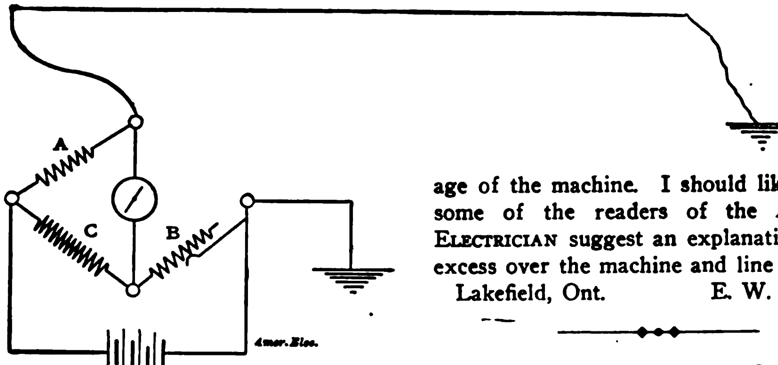


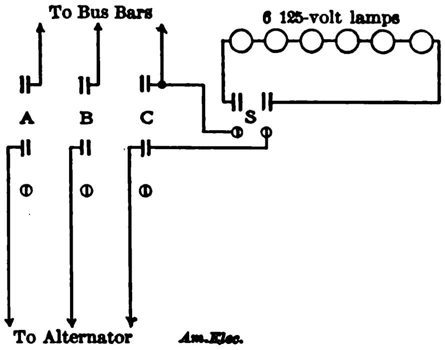
FIG. 1.—PROBLEM IN BROKEN WIRES.

John J. Marshall.
San Francisco, Cal.

Voltage on Synchronizing Lamps.

To the Editor, American Electrician:—

In synchronizing a 550-volt alternator with the bus-bar e.m.f., we have found trouble due to excessive voltage across the synchronizing lamps. The voltmeter shows 540 to 550 volts at the bus-bars and the same between each pair of leads from the terminals of the generator being synchronized, but the voltage across the lamps is over 700 volts. The accompanying diagram shows what the essential connections are between the bus-bars, the synchronizing lamps and the machine being thrown in. The machine is three-phase and the frequency is 60 cycles. The switch *A* and the synchronizing switch *S* are closed for synchronizing, so that when the machine is in step with the line the lamps are dark. Before it gets into synchronism, however, the voltage across the lamps runs up as high as 720 volts, so that we have to use six 125-volt lamps in series instead of five 110-volt lamps corresponding to the voltage of the machine. I should like to have some of the readers of the American Electrician suggest an explanation of this excess over the machine and line voltage.



CONNECTIONS FOR SYNCHRONIZING.

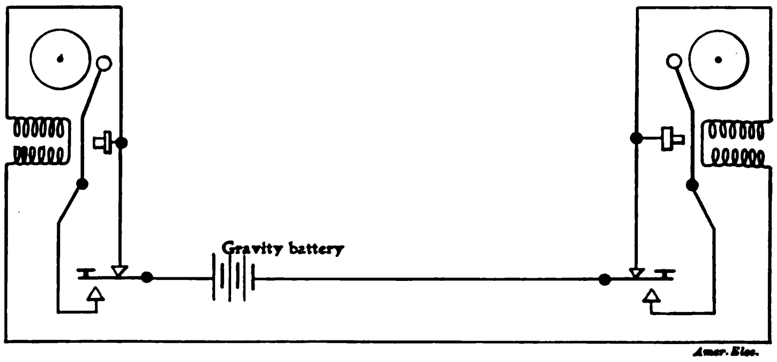
Lakefield, Ont. E. W. Bailey.

◆◆◆

Mr. Smith's Problem in Bell Connections.

To the Editor, American Electrician:

The accompanying diagram is submitted as a solution to Mr. Martin Smith's problem published in the December number of the American Electrician, the requirements of which were that two ordinary vibrating bells should be operated from a two-wire circuit with one battery and two push-buttons. Referring to the diagram, it will be evident that two-way push-buttons are used and that so long as they are not depressed the circuit is closed through the battery and the magnets of both bells, so that the bell clappers are normally held up against the bells. This makes the system a closed-circuit one, so that a gravity battery is required. If one of the push-buttons be depressed, the circuit will be opened and both of the armatures will fall against their backstops. This action by the bell armature at the distant station does not affect the circuits in any way, but when the armature of the home bell falls back against its stop, it recloses the circuit which has been opened by the depression of the push-button and the two magnets are again energized and therefore pull the hammers against the bells again. These actions, of course, continue as long as the push-button is depressed, the vibrator of the home bell causing both of the bells to ring, while the vibrator of the distant bell has no effect because the armature of that bell is not connected to the circuit in any way.



SOLUTION OF MR. SMITH'S PROBLEM IN BELL CONNECTIONS.

John E. McKivitt,
Frank Carswell.

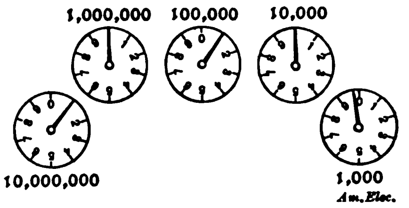
[Note.—The foregoing solution is the only one thus far received which is at all practical, and the ingenuity involved is highly commendable. We have received a great many proposed solutions, but most of these were substantially identical with the undesirable arrangement described in the editorial note appended to Mr. Smith's letter in the December number; the remainder were either too complex or inoperative.—Editor.]

◆◆◆

A Tricky Meter Reading.

To the Editor, American Electrician:—

I enclose herewith a copy of a meter reading as it appeared on a customer's meter. I did not think it particularly difficult until several experienced meter readers made mistakes in determining the reading; but in view of that fact it may be of interest to your readers.



A TRICKY METER READING.

New York. Ralph Ryder.

[We shall be glad to have interested readers submit readings of these meter dials, for publication or not, as they prefer. The correct reading is on file in this office. —Editor.]

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

Can the two-cycle gasoline motor described in the February number be used in a launch, and if so, what size should the hull be? J. D.

Yes, the motor will drive a 20-foot open launch at a fair speed.

What effect do small particles of copper in the bluestone of a gravity battery have upon its efficiency? R. L. L.

Practically none; pieces of copper of appreciable size, however, mixed with the bluestone crystals will impair the action of the battery somewhat.

What is a split-pole generator? (2) Does it deliver direct or alternating current? L. S.

It is one form of Lundell direct-current dynamo built by the Sprague Electric Company. The magnet poles have a slot from a point very near the pole face to a point very near the yoke-ring; hence the name "spilt-pole."

How can an apparatus requiring 6 amperes and 110 volts, direct current, be operated from a 500-volt direct-current circuit, using lamps to take up the difference in voltage? T. P. H.

A rather elaborate bank of lamps will be required; you will have to connect four groups of 100-volt 16-c.p. lamps in series, each of the four groups containing 12 or 13 lamps in parallel.

Can ordinary dry batteries be used to run a small motor instead of storage batteries? V. V. W.

Yes, if you refer to the very small motors wound for battery current, such as the Knapp and the smaller of the two Edison machines described in the fan motor article, this issue. Batteries of the Edison-Lalande or Gordon types are preferable, however.

Is it practicable to use acetylene gas in the ordinary gas burners or gas stoves? If not, why? E. K.

No, for the reasons that the gas clogs up the burners and the delivery opening of the ordinary gas burner is too large. The clogging is due to the excessive proportion of carbon contained in the acetylene gas, which requires a special burner to produce proper combustion.

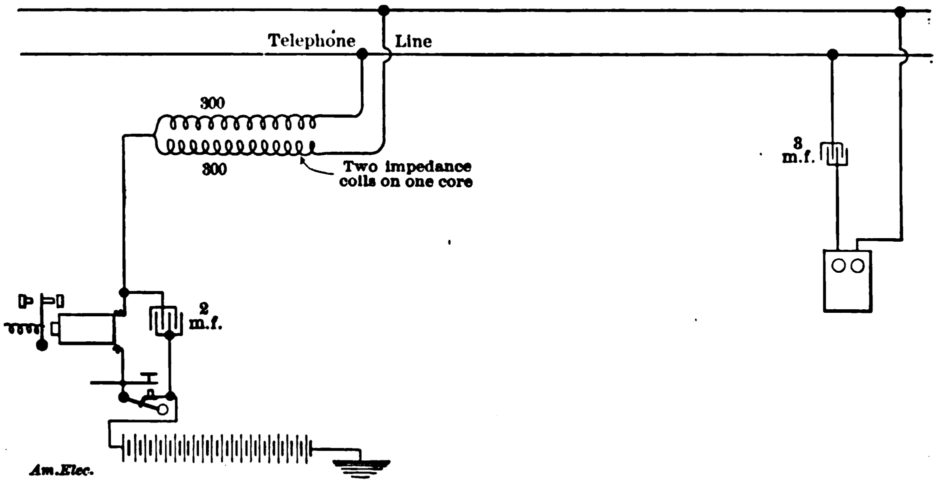
If the external resistance of a circuit supplied by 130 cells of Daniel battery should be increased from 120 ohms to 140 ohms, how many cells of battery must be added to the original 130 in order to prevent the increase in external resistance from reducing the current in the circuit? T. F. H.

The external resistance has been increased 20 ohms, and $\frac{20}{120} \times 130 = 21.66.$

As you cannot add a fraction of a cell, 22 is the proper number to add.

We have a metallic-circuit telephone line and desire to connect a set of telegraph instruments at one end and at a point about one-third the length of the line distant from the far end. Please give a diagram showing the proper connections and specify whatever special instruments will be necessary. A. E. C.

The telegraph instruments may be connected as shown by the accompanying diagram, using ordinary 150-ohm Western Union relays. Each pair of impedance coils must be wound differently. The diagram shows only one set of instruments; both sets are connected to the line in exactly the same manner except that the positive terminal of the other battery must be grounded so that the two batteries will agree. Each set of telephone instruments should be put in series with a condenser, as indicated.



If one boiler is disconnected from a battery, will the boiler foam or will the entire battery foam? (2) How can the requisite throw of an eccentric be ascertained for a Corliss engine with the usual releasing gear? O. F. S.

If the boiler which is disconnected ceases to do work when it is disconnected, the mere act of disconnecting it will not cause it to foam. If, however, it remains connected to a pipe supplying a working engine and the amount of steam required by the engine exceeds the working capacity of the boiler it will probably foam when disconnected from the battery. Similarly, if the entire battery of boilers is being worked to the limit, disconnecting one of them will increase the load on the others and tend to produce foaming in them. (2) This depends upon the type of gear employed. The best plan is to ask the manufacturer of the engine.

Can the complete field ring and magnet poles of the 2-kw. double-current machine described in "Electrical Designs" be built up of laminations instead of using laminated poles cast into a solid iron ring? I have a lot of 9-inch armature discs available for the purpose; what difference would the extra ¼ inch in the outer diameter make? (2) Where can I obtain castings for the two-cycle gas engine described in the February number? C. F. S.

Yes; while laminating the yoke-ring is not necessary, the machine will give better results that way than if a solid yoke-ring were used. The excess of ¼ inch in diameter will merely make the machine a trifle heavier than it needs to be. The laminations should be clamped between two heavy iron rings conforming to the inner and outer circles of the yoke-ring and the magnet structure should preferably be mounted in a light cast-iron housing. (2) Probably from Parsell & Weed, 129 West 31st Street, New York City.

The ordinary mufflers that are used with gas or gasoline engines to deaden the noise of the exhaust impose back pressure on the engine and thereby reduce its power. Would it not be practicable to lead the exhaust from a gasoline engine into a well in the ground, having 70 times the cubical capacity of the engine cylinder, and to lead the exhaust gases out of the well through a three-inch pipe? The exhaust pipe of the engine is 2½ inches in diameter. (2) Would there be any danger of explosion in the well? H. P. W.

Such an arrangement would probably be effective enough, but it would seem to be unnecessary in view of the fact that mufflers can be obtained which do not reduce the power of the engine to an objectionable extent. (2) This would depend upon the performance of the engine. If the combustion was incomplete in the engine or any charges went through unignited there would be liability to explosions in the well.

Please describe two different methods of adjusting the compounding of a direct-current dynamo. (2) How are storage batteries put in and out of commission? D. P. R.

There is only one practical way of adjusting the compounding of the ordinary dynamo, and that is by varying the resistance of a shunt conductor connected to the terminals of the series winding. If the series winding were divided into sections with taps led out from the junctions of the sections, the compounding could be adjusted by cutting in or out one or more of the sections, but this would be an extremely clumsy method. (2) When a storage battery is put in commission the plates should be assembled in the jars, the electrolyte poured in and the battery immediately connected to the charging circuit. The first charge should be at its full rated capacity and after it is fully charged, that is to say, when the electrolyte begins to bubble, the charging current should be reduced to as low a point as possible without causing the bubbling to cease, and the battery should then be overcharged somewhat. The proper amount of overcharging varies with different types of battery. In order to put a battery out of commission it should be fully charged, then the electrolyte drawn off and the cells filled with pure water. The battery should then be allowed to discharge as far as it will, then the plates should be taken out of the water, thoroughly dried immediately, and put where the air does not have free access to them.

LARGE PIPE ORGAN FOR ST. LOUIS EXPOSITION.

One of the most interesting musical and semi-electrical features of the St. Louis Exposition will be the immense pipe organ built by the Los Angeles Art Organ Company, of Los Angeles, Cal., for the Kansas City Convention Hall Company, and which will be the official concert organ at the Festival Musical Hall. It is, we understand, the largest pipe organ in the world. It has 130 miles of electric wire, 140 speaking stops, 1300 magnets, 99 mechanical movements and weighs 250,000 pounds.

Fig. 1 herewith shows the organ set up in the factory, without the display pipes; and its relative size can be inferred from the surrounding objects. The instrument will be played from two independent consoles. The most important console is movable (Fig. 2) and is connected to the organ by an electric cable 150 ft. long. This console contains the radiating and concave pedal clavier, the five manual claviers, the 140 draw stop knobs, the five tremulant draws and the 36 coupler draws, the 46 push buttons belonging to the adjustable combination system, and all the foot pedals controlling the expressive powers of the whole organ, etc., etc. This console is for the virtuoso who performs in the usual manner with hands and feet.

The second console is stationary, and is entirely devoted to the builders' double-roll automatic self-playing attachment. Through the agency of the double or twin rolls, the most complicated orchestral scores can be rendered with absolute accuracy, and compositions can be performed which are far beyond the powers of the most accomplished organist. This console resembles that first described, except that it does not possess the manual and pedal claviers, which are not necessary where the double-roll, self-playing attachment appears. Within its arms, so to speak, sits the musician, with the calls of six claviers upon his hands and feet, having at his immediate command the vast tonal forces (represented by 10,000 pipes) of this gigantic organ; his hands simply engaged in manipulating the draw-stop knobs and combination buttons, and his feet controlling the flexible and expressive powers of the instrument. The double rolls do all the rest.

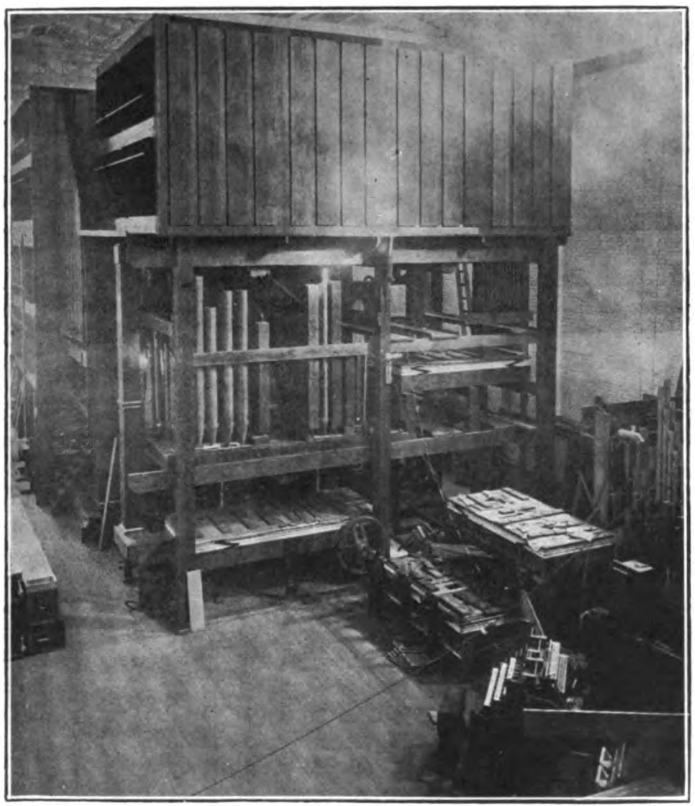


FIG. 1.—FLEMING ELECTROPNEUMATIC PIPE ORGAN.

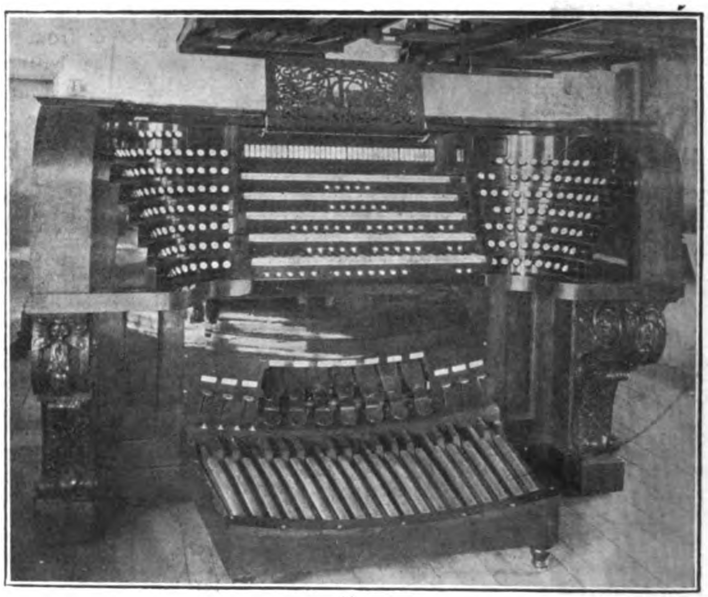


FIG. 2.—MOVABLE CONSOLE OF ORGAN.

The bellows of the main portion of the organ will be operated by two 10-h.p. motors, at 220 volts, direct current. The echo organ bellows will be operated by a 1½-h.p. motor of 220 volts, direct current. The wind-chests, through which the wind from the regulators is distributed to the 140 speaking stops, and the 10,059 pipes, are 12 ft. long and of widths sufficient to give every rank of pipes planted thereon ample speaking room.

The organ is constructed under the Fleming electropneumatic system, which gives the most satisfactory results. The organ contains 1300 magnets, as noted above, for both key and draw-stop actions. There are 130 miles of wire in magnets and cables, from No. 20 up to No. 34 B. & S. gauge. There are also 1616 automatic combination knobs for setting combinations electrically throughout the organ. There are five automatic electric swell engines for the actuation of the swell shutters. There are above 7000 open circuits in the organ. The company's special contact wire is used in the key and coupler actions. The single-contact system is used, so arranged as to be durable and always reliable. The coupler action contacts clean themselves automatically, and all trouble is thereby prevented. The storage batteries used will have four cells of two volts each, with normal discharge of 50 amperes for eight hours. There will be a motor-generator of 220 volts, direct current, with a capacity of 10 volts and 40 amperes, to charge the batteries.

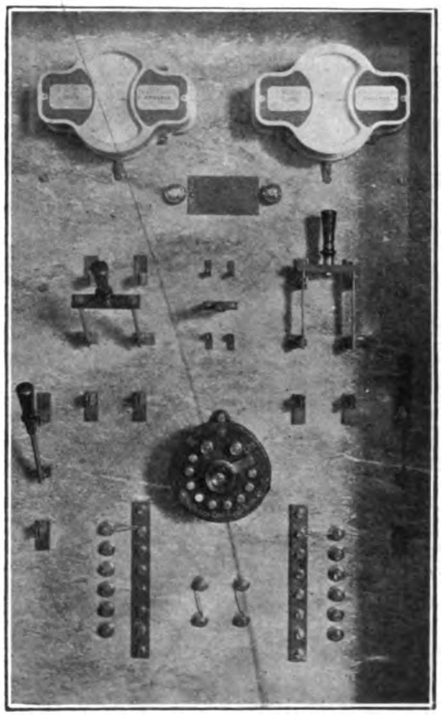


FIG 3.—ORGAN SWITCHBOARD.

The switchboard (Fig. 3) has a voltmeter and ammeter to show the discharge voltage and strength of the batteries at all times. There will also be a polarity indicator, also a pilot lamp, which will indicate, to a certain extent, the strength of the batteries. There are also a voltmeter and an ammeter on the switchboard, one showing the voltage charging the batteries and the other showing the amount of the current going into the batteries. Switches are provided for throwing the generator on and off, and for throwing the current off the organ when not in use. The switchboard consists of a marble slab mounted in a handsome oak case with glass door for display purposes.

New Apparatus and Appliances

CRANE MOTOR CONTROLLERS.

Controllers for crane motors and other service where frequent starts and reversals are involved must, of course, be unusually substantial in order to withstand the wear and tear of constant usage. They must also be simple and positive in action and afford the desired degree of control with the fewest manual movements. In order to meet these requirements, the Westinghouse Electric and Manufacturing Company has brought out the types of controller illustrated by Figs. 1 and 2 herewith. Practically the only difference between the two forms is in the manner of mounting the resistance coils and the rheostat mechanism. The type shown in Fig. 1 is for moderate outputs and that shown in Fig. 2 is for heavy service. The rheostat is of the commutator type, the contact plates being mounted horizontally on the periphery of a slate slab instead of radially as in the ordinary rheostat. The contact brushes or fingers are mounted on the outer ends of the four spider arms shown in the illustration, and these also carry blow-out magnets to reduce the sparking when the circuit is opened. The controllers are of the reversing type, so that only one handle has to be manipulated. Moving the handle to the left from the "off" position operates the motor in one direction, and moving it to the right operates it in the reverse direction. The distance through which the handle is moved determines the speed of the motor, of course, by cutting out more or less of the resistance coils. When the controller is located in the rear of a crane cage the brush spider is controlled by means of a bell-crank and link-rod, as shown in Fig. 1. The resistance conductor in the controllers for motors of small capacity is of the coil type, with ventilating spaces between the coils, which are separated by non-combustible insulating blocks, as shown in Fig. 1. The conductor in the controllers for large motors is of the grid type, as Fig. 2 indicates upon close inspection. These controllers are built for motors ranging from 10 to 75 horse power. For motors of less than 10 horse power, the company builds the ordinary face-plate or dial type of rheostat front; the brushes are mounted on a four-arm spider, as in the apparatus just described, but blow-out magnets are not required.

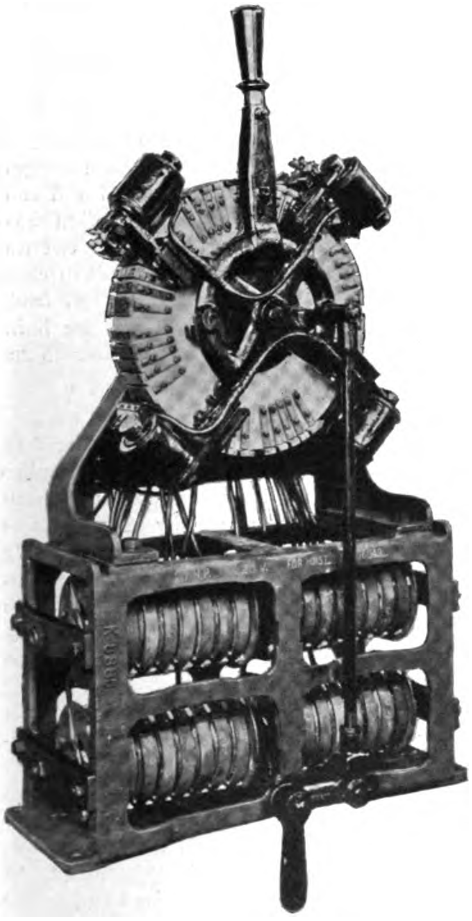


FIG. 1.—CRANE MOTOR CONTROLLER FOR MODERATE OUTPUT.

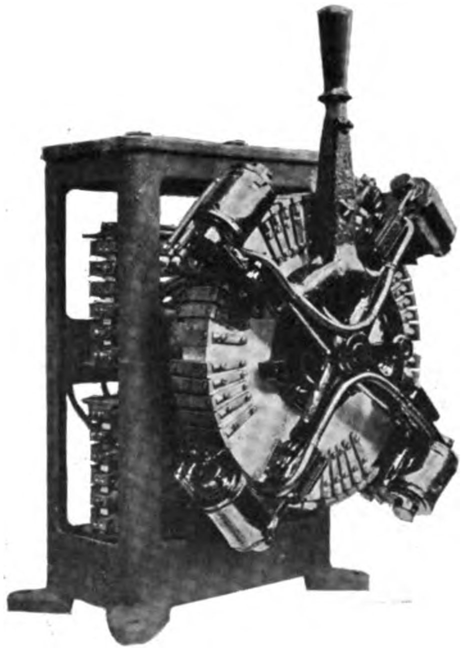


FIG. 2.—CRANE MOTOR CONTROLLER FOR HEAVY OUTPUT.

"IDEAL" GENERATORS.

Fig. 3 herewith illustrates a new line of direct-current generators now being built by the Ideal Electric & Manufacturing Company, Mansfield, Ohio. These machines are built with four poles up to the 40-kw. size and six poles in sizes larger than 40 kilowatts. The magnet frame is of cast-iron, with the field magnet cores cast-welded into it; the frame is divided horizontally, as shown in the engraving. The magnet cores are of cast-steel, of circular cross-section, and equipped with cast-iron pole-pieces or shoes, shaped so as to obtain the requisite gradation of the commutating magnetic fringe. The armature is of the slotted-drum type, and the coils are machine-wound, hand-insulated, varnished and baked before going in the slots; the winding is of the straight-out or "barrel" type, as indicated by Fig. 4. The core is ventilated by transverse ducts at short intervals. The armature discs of the larger machine are mounted on a spider keyed to the shaft; in small machines, the discs are threaded directly on the shaft and keyed thereto. The end-plates which compress the armature discs together are provided with ribbed flanges which ventilate the projecting portions of the winding at each end of the armature. The winding is held in the slots by binding wires.

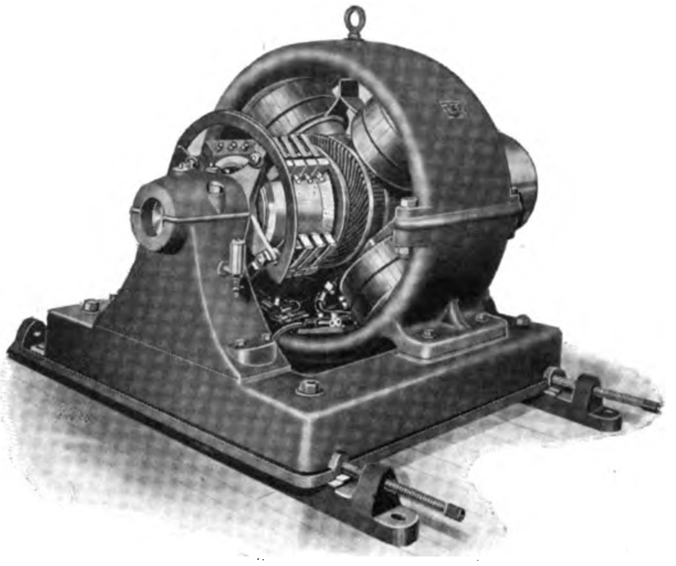


FIG. 3.—"IDEAL" DIRECT-CURRENT GENERATOR.

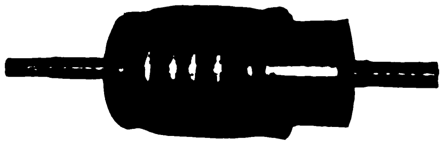


FIG. 4.—"IDEAL" ARMATURE

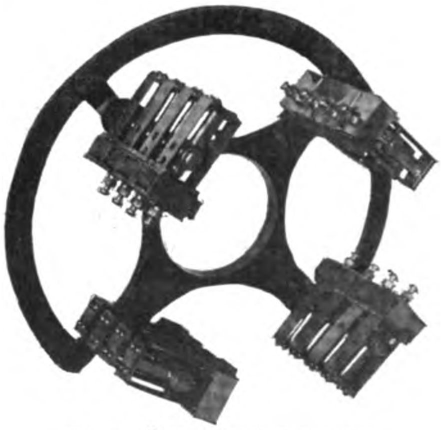


FIG. 5.—"IDEAL" BRUSH RIGGING.

The brush-holders are of the so-called parallel-motion type, with the brushes bolted to plates which are secured to the extremities of two flat springs, the other extremities of which are bolted to the stationary part of the rigging. Fig. 5 shows the complete brush rigging of a four-pole machine, from which engraving the construction will be evident. Copper-coated composition brushes of carbon and graphite are used, and the cross-section is such, it is stated, that the current density at the brush faces does not exceed 30 amperes per square inch. These machines are said to show full load temperature rises of not over 63° Fahrenheit at the commutator and 54° elsewhere.

TELEPHONE CARD DIRECTORY.

The accompanying illustration shows a new form of telephone directory invented by M. Holtz, of New York City. This directory is in the form of a nickeled bracket which may be clamped to the post of a portable telephone apparatus, and contains cards arranged as in a card index, permitting any classification—by business, alphabetically or in any other way to suit the convenience of the user. A card may be withdrawn and any number of names of the same general classification, up to the capacity of the card, may be seen at a glance, the card dropping back to its place by its own weight. The projecting tabs on the cards give a quick guide to the contents, and permit the ready withdrawal of any card.

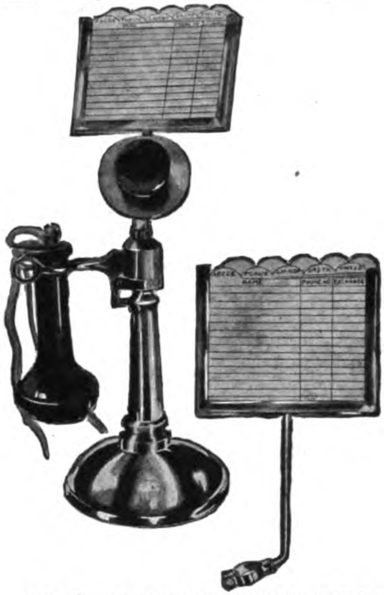


FIG. 6.—TELEPHONE CARD DIRECTORY.

IMPROVEMENTS IN ELECTRIC SIGN FLASHERS.

Some improvements have recently been made in the electric sign flashers made by the Reynolds Electric Flasher Manufacturing Company, of Chicago, which, although they might seem trivial to the layman who is not well acquainted with sign flasher work, are nevertheless important as regards the results attained. In flashers as usually constructed, the various individual switches were operated by removable cams or segments which could be adjusted to any position on the periphery of a wheel. There is one such wheel to each switch and each wheel has its cam clamped in proper position. Where several circuits of a sign were to be flashed at once, it was found difficult to adjust these cams so that they would open and close the circuit simultaneously. The new construction, which is much simpler and more substantial, consists in using a sheet steel shell instead of the cams or segments. The accompanying illustration shows a flasher built to flash two sides of a sign alternately. The eight contacts at the right-hand end flash one side of the sign and the eight contacts at the left the other side. The straight edge of the sheet steel shell insures simultaneous action of the various switches and does away with the so-called "ragged effect" on the sign. The shell being screwed directly to the flasher wheels, it cannot get loose or out of adjustment as easily as individual segments, and, furthermore, the segments require a wheels for each switch. With the shell only a few wheels are required; enough to give it stiff support. There are some combinations where it may still be necessary to use the removable segments, but by notching the steel sheet, it can be made adaptable to a large number of combinations.

FIG. 7.—REYNOLD'S SIGN FLASHER.

NEW VARIABLE SPEED MOTOR.

The Commercial Electric Company, Indianapolis, Ind., has brought out a new line of variable-speed motors for operation on a simple two-wire direct-current circuit. The general appearance of the new machine is shown by Fig. 8 herewith and Fig. 9 is a view of the "Universal" type of interlocking controller and stand built for use in conjunction with the new line of machines. The motors are of the double-commutator type, having two armature windings exactly alike connected to commutators at both ends of the armature. The controller connects the two armature windings in series or parallel, according to the speed requirements, and also modifies the field-magnet excitation of the machine in order to give intermediate speeds between zero and maximum with the armature windings in series, and between the maxima with the windings in series and in parallel. The controller is equipped with two handles; the small handle at the right is used only for starting and stopping the machine, and the handle shown on top of the stand actuates a cross-bar carrying contact brushes at its ends which travel over radial contact segments inside the case. This latter switch controls the connections of the two armature windings and also varies the field-magnet strength. The panel mounted in the frame of the controller carries a double-pole circuit-breaker and two enclosed fuses. The range of speed control is four to one, divided into twelve uniformly-graduated steps which do not overlap. As no external resistance is used in the armature circuit, the machine runs at a practically constant speed at each speed point of the controller regardless of changes in load, and is capable of exerting its maximum horse-power at each speed. The efficiency is said to be practically constant at all speeds and high at all loads. The 5-h.p. machine, for example, has an efficiency of 80 per cent. under full load at 400 r.p.m., 76 per cent. under full load at 1,000 r.p.m., 75 per cent. at 1,500 r.p.m. and 79 per cent. at 1,600 r.p.m. The efficiency under variable load at 400 r.p.m. ranges from 70 per cent. at 2 horse-power up to 80 per cent. at 6 horse-power. The results of tests for speed uniformity are also interesting. With the controller on the first step, the speed ranges from 400 r.p.m. to 360 r.p.m.; on the fifth step, the speed ranges from 840 to 800, between no load and full load; on the ninth step, the variation was from 1,260 down to 1,200, and on the twelfth step, from 1,650 to 1,610, the figures in each case being those at no load and full load, respectively. The new machines are built in sizes ranging from 2 horse-power to 20.

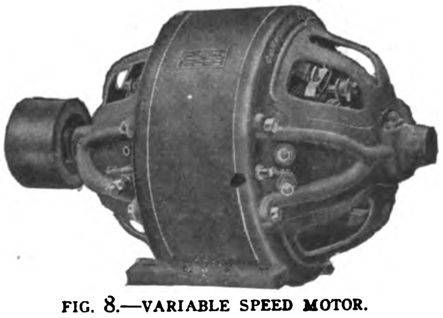


FIG. 8.—VARIABLE SPEED MOTOR.

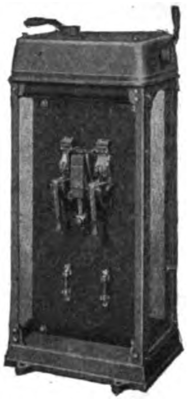


FIG. 9.—"UNIVERSAL" CONTROLLER.

THE HEANY ARC LAMP.

Since the Heany arc lamp was described in this department (July, 1902), a number of changes and improvements have been made in it which are worthy of note. The supporting stays are made of ⅜-inch tubing instead of 5-32-inch rods. The lamp has been provided with a top casting, on which is mounted a substantial switch and binding posts. The binding posts are mounted on porcelain, and have — and + signs plainly visible. They have also large binding screws and wire holes large enough to accommodate No. 6 wire. The resistance wire is wound on a porcelain ring which surrounds the supporting tubes; the porcelain ring is cut with a thread of 10 pitch, and the wire is wound in this thread. A novel vice-like clamp slides in a slot in the porcelain ring to cut in or out the resistance wire for various line voltages. The solenoid spool is held on the supporting tubes by six strap clamps, instead of screws as in the old lamp. The dash-pot in the earlier lamp was made of drawn tubing; it is now cast and reamed, increased from ½-inch to ⅝-inch, and is fastened to one of the supporting tubes with a clamp, the supporting tube being provided with a locating pin, which brings the dash-pot to the proper place. In the old lamp no provision was made for locating the dash-pot. The clutch is made entirely of stampings, instead of castings. The carbon receiving tube has been increased in diameter from ⅝-inch to ¾-inch, permitting the use of ½-inch carbon if desired, so as to interchange with the other type of Heany lamps. In fact, in improving the lamp this point has been carefully considered, and the casing, carbon receiving tube, supporting tubes, globes and all principal parts will interchange on all the types. The casings are made of copper, and are well ventilated, as well as weather-proof. The lower carbon holder has been provided with a cam to lock the carbon, instead of a screw, and has a projection which limits the weight of carbon and is of importance in trimming. The spider on the base of the lamp has been dispensed with and a projection from the base of the lamp takes its place. In the old lamp the carbon was partially exposed; in the new lamp this space is closed, making a bearing for the carbon, and preventing admission of oxygen to the inner globe, thereby prolonging the life of carbons, and at the same time simplifying the construction. The internal parts are copper and nickel-plated to prevent corrosion and oxidation. Mica and porcelain are used throughout as insulation.

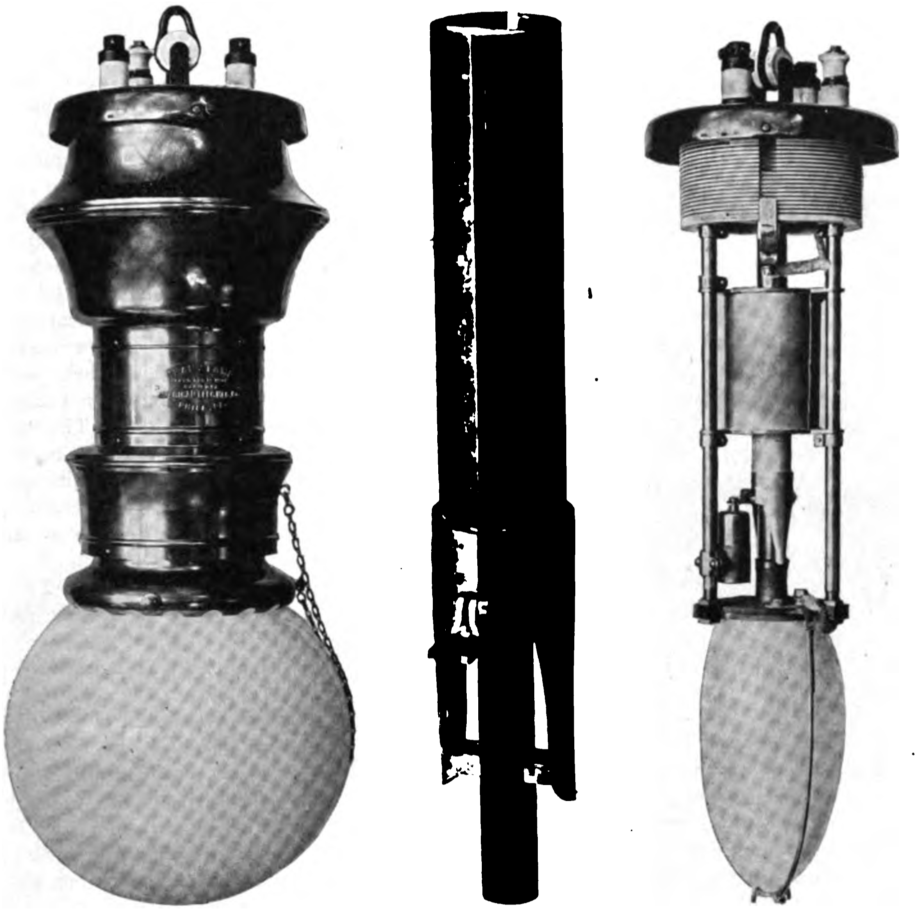


FIG. 10.—HEANY ARC LAMP AND DETAILS.

TYPE W SPRAGUE HOISTS.

Fig. 11 herewith shows one of five Sprague hoists installed in the foundry of the Brown & Sharp Manufacturing Company Providence, R. I., on cranes designed by the company. Fig. 12 shows the hoist and trolley carriage. It will be noticed that the hoist is very compact, the motor and gears being entirely enclosed, the latter running in an oil casing. An F-2 Sprague controller is mounted on the end of the bridge to the right and is operated from the floor by hanging cords. This controller is said to be especially designed for foundry work and to permit of several slow positive hoisting and lowering speeds in addition to full speed. A test made on one of the first hoists installed with the controller on the first contact gave a hoisting and lowering speed of almost 16 inches a minute, both with empty hook and with a three-ton load. 'The full speed of the hoist with five tons was about 8 feet per minute. A limit switch is provided with the hoist to prevent damage caused by jamming the rope sheaves against the gear case. This switch is shown in the engraving attached to the bottom of the gear case. A lower limit can also be furnished to prevent the rope from entirely unwinding from the drum.

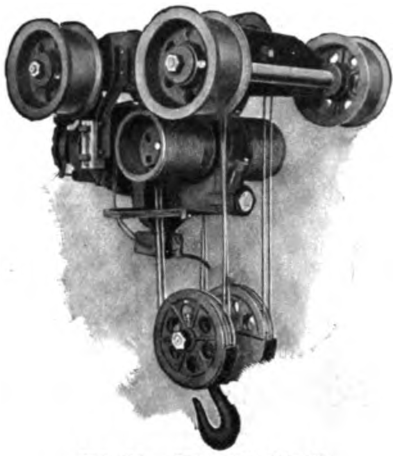


FIG. 11.—SPRAGUE HOIST.

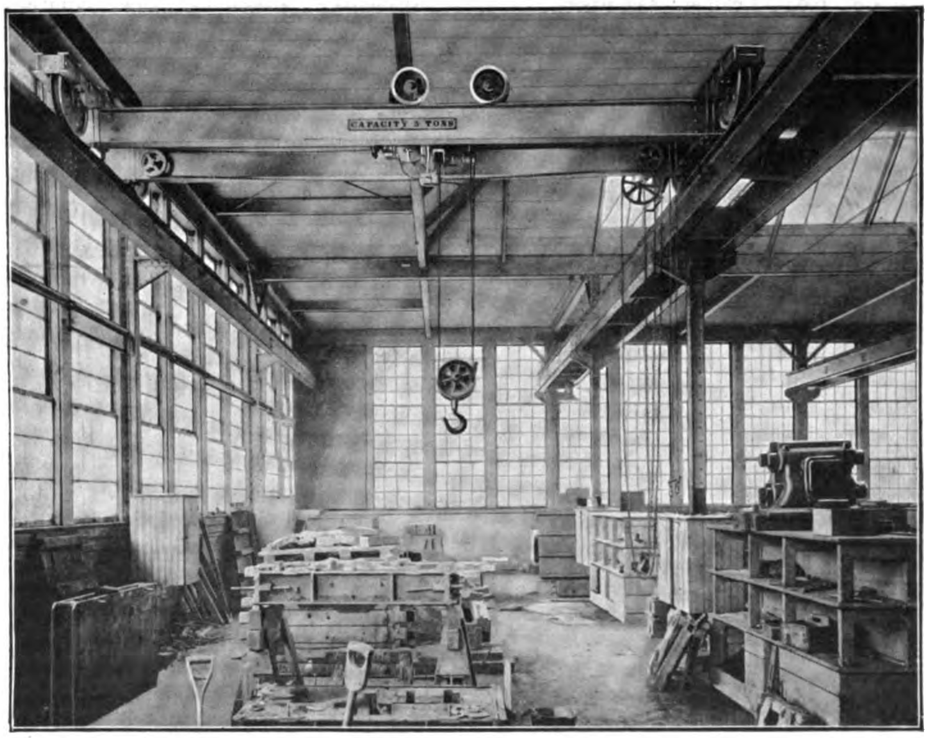


FIG. 12.—BROWN &SHARP FOUNDRY, SHOWING ELECTRIC HOIST.

NEW STAR SPEED LATHES.

The Seneca Falls Manufacturing Company, of Seneca Falls, N. Y., has brought out a new 10-inch and a new 12-inch lathe which embody in their construction several new features of interest to users of this class of machines. The head-stock is of the web pattern. Its spindle is forged from crucible steel and runs in dust-proof and self-oiling bearings of phosphor-bronze.

The cone pulley has four steps and is turned inside as well as outside. The tail-stock is of the curved or cut-out pattern. The tail spindle has a new combination screw and lever motion with a dial, graduated in sixteenths, which is valuable in drilling, counterboring, countersinking, etc., to a desired depth. To change from screw to lever motion it is only necessary to loosen the thumb-screw and the spindle sleeve is released. When not in use the long hand-lever can be lifted off. The tail stock has a long bearing on the ways and is firmly locked to the bed by a convenient lever. The hand-rest is provided with long and short T-rests. The rest-socket and saddle are locked to the bed by a cam locking device and the T-rest is held in the socket by a friction clamp. Both of these devices are operated by levers. The bed is broad and deep and well braced. The front way is flat and the back way is V-shaped. Secured to the back of the bed is a convenient shelf for the reception of tools. The countershaft has self-oiling and self-aligning bearings, a four-step cone and tight and loose pulleys. Friction clutch pulleys are furnished if desired.

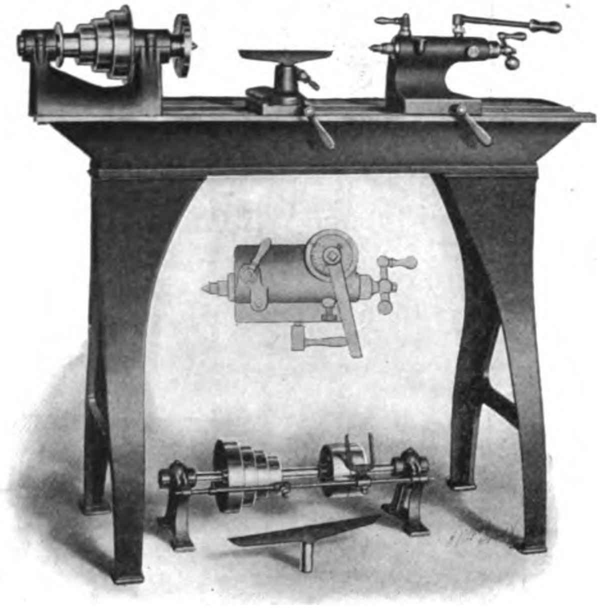


FIG. 13.—"STAR" SPEED LATHE.

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NEW BOOKS.

Modern Wiring Diagrams and Descriptions. By Henry C. Horstman and Victor H. Tousley. Chicago: F. J. Drake & Co., 1904. Leather; 152 pages, 4 ins. x 6 ins.; 177 illustrations. Price, $1.50.

This little book contains an excellent collection of diagrams and a reasonably complete explanation of them in the text. The diagrams cover all classes of circuits that a wireman or other practical worker will be likely to encounter, and a considerable number that he probably never will have to deal with. One should not object, however, to more information than is required. The authors' diction is open to criticism, and the use of symbols is not always judicious; for examples: "The positive of the machine is connected to the positive of the circuit"; "leading wires," meaning individual wires; "multiphase" instead of "polyphase"; "Magnet A * * * * is almost impenetrable to rapidly alternating or intermittent currents"; "transformer," in the fourth line of page 104, referring to an autotransformer; the use of *C* to represent amperes instead of the recognized symbol *I*, and the use of a circle to represent an annunciator magnet. These little points are of more importance in a book directed to the audience for which this one is intended than they would be in a more abstruse work written for men who are less likely to accept as a guide every utterance of an author. Barring the minor lapses of the sort mentioned, the book has the merits of technical accuracy, clearness and completeness.

A Text Book of Electrical Machinery, Vol. I. By Harris J. Ryan, Henry H. Norris and George L. Hoxie. New York: John Wiley & Sons; 1903. Cloth; 265 pages, 5½ ins. x 9 ins.; 134 illustrations. Price, $2.50.

This volume is devoted to the exposition of fundamental principles and is intended to prepare the student for a thorough comprehension of Volume II, which will be devoted to the analysis of the structural and performance characteristics of electrical machinery. In the present volume the authors start at the beginning, dealing first with the basic principles of electricity and magnetism, fundamental and derived units. The treatment in the first few chapters is a rather inconsistent mixture of highly mathematical exposition and childishly simple problems. For example, after carrying the student through a chapter bristling with trigonometrical formulas, and another dealing with complex quantities, the authors propound this staggering test: "A current of 105 amperes is furnished by the armature of a railway generator that has a resistance of .15 ohm; what e.m.f. is consumed in the armature?" The next problem is one to which the answer, as expressed by the authors, is 2095 /47°8′ volts; this unusual expression is a composite one, intended to convey the information that the e.m.f. is 2059 volts and leads the current by 47° 8′. With full respect for the authors, this manner of statement impresses the reviewer as being clumsy, confusing and totally unnecessary. Barring a few mannerisms, so to speak, of this kind, the book can be recommended unqualifiedly to students who already have a fair knowledge of geometry and trigonometry. It is the only one that has thus far come under the reviewer's notice in which the exposition of the inductance and capacity of the two parallel wires of an alternating-current circuit is both accurate and unmistakably clear; it is to be regretted that the authors did not extend their discussion to three-phase circuits.

Mechanical Engineers' Reference Book. By H. H. Suplee, M.E. Philadelphia: J. B. Lippincott Company. Soft leather; 842 pages 4 ins. x 7 ins.; illustrated. Price $5.50.

This is a finely executed and well-planned member of the engineer's "pocket book" class which contains several features not found in previous books of that kind. There is a very useful multiplication table by means of which one may ascertain the product of any digit and any number of two figures by inspection, and of two numbers of any reasonable magnitude by simple addition; there is also a factor table giving the factors of all composite numbers up to 9,600, excepting those divisible by 2, 3 and 5. The table of trigonometrical functions is arranged in steps of one minute, instead of 10 or 15, as in most other similar books, and is supplemented by a table of logarithmic angular functions. The table of hyperbolic logarithms progresses in steps of .01 up to 10 and thence in units steps up to 134. There are the usual sections on mechanics, materials and strengths of materials, but these are somewhat fuller than usual, and are followed by a most useful section on machine design heretofore lacking. Cost of power and works management are also new headings, although most of the other books contain some material on the former of these two subjects. A thorough review of the book is impracticable, of course, in view of the diversity of subjects; so far as the reviewer has been able to test the merit of it by analysis or application of the contents, the author's work has been very accurately and conscientiously done. Errors will doubtless be found as one puts the book to practical use, but the first inspection has revealed very few. Probably the worst, *per se*, is the statement taken from another hand-book, that the brake horse-power of a gas engine is proportional merely to the stroke, speed and square of the cylinder diameter, without any consideration of the compression ratio. In the electrical section, the author manifests inconsistency with accepted practice by using *C* to represent current, although *P* is used to represent power; in copying the Institute table of copper wire properties he has retained the less convenient "Feet per Ohm" section and omitted the more convenient "Ohms per Foot" section. Some excellent records of tests made on motors for machine-tool drive are included, but otherwise the section consists of reprints of the A. I. E. E. table just mentioned, the Underwriters' Rules, the General Electric Company's wiring formulas and tables, the report of the A. I. E. E. Standardization Committee and some fugitive quotations from papers and articles on motor drive. The non-electrical parts of the book are far more complete and satisfactory—naturally, perhaps.

Secondary Batteries. A Practical Handbook for Owners and Attendants. By an Engineer. London: H. Alabaster Gatehouse & Co., 1903. 83 + viii pages 5¼ by 8 inches; 8 illustrations. Price 4 shillings.

This little volume has both a preface and an introduction. The preface opens thus: "The writer of this book is an Engineer, and not an Electrician. He has attempted, therefore, to write, not Electricity, but En-

American Electrician.

Vol. XVI. New York, April, 1904. No. 4.

THE STEAM TURBINE IN POWER HOUSE EXTENSIONS.

CENTRAL STATION OF THE ROCKLAND LIGHT & POWER COMPANY.

An interesting application of the steam turbine to existing conditions in central station practice may be found at the power station of the Rockland Light and Power Company, located at Orangeburg, N. Y. This company operates an alternating-current distribution system covering considerable territory in the southeastern section of New York State, including as many as twenty towns and villages. The system extends from Nyack, N. Y., on the north to Cresskill, N. J., on the south, and from the Hudson River as far inland as Spring Valley and Monsey N. Y. The power house supplies 3000-volt 2-phase current for all purposes, the power being transmitted by high-tension feeders to the various distribution centers and there stepped down by transformers to voltages suitable for commercial and private lighting and street arc lighting. For the latter, tub transformers are employed in connection with constant-current, alternating, enclosed series arcs.

A considerable motor load is carried through the day, the majority of the motors being of the polyphase constant speed induction type. These motors furnish power for operating various machine shops and factories located within the territory cov-

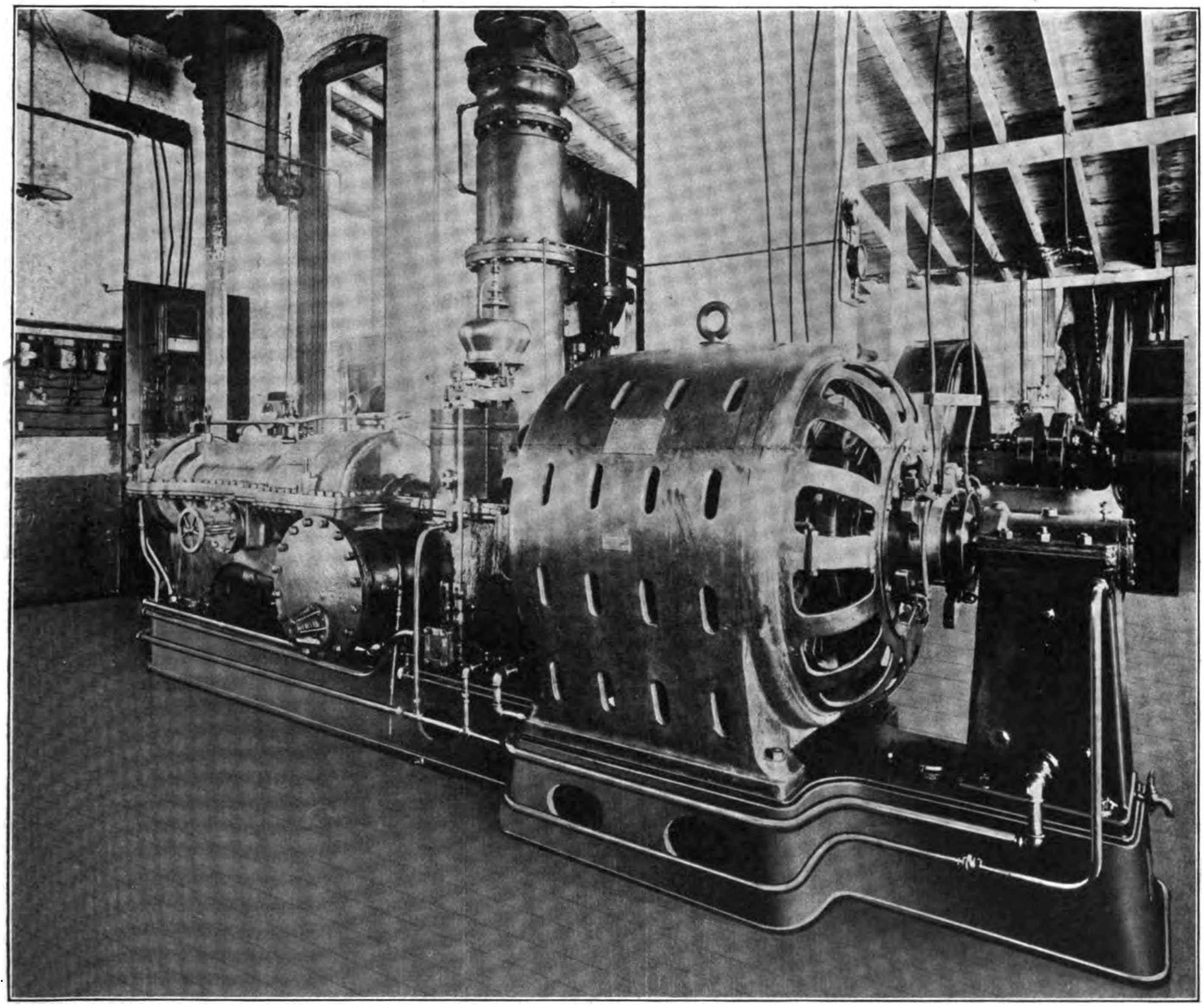

FIG. I.—TURBO-GENERATOR IN ROCKLAND LIGHT AND POWER COMPANY'S STATION.

ered by the company's distribution system.

The power station at Orangeburg contains at present about 800 kw. of generating machinery, mostly of the polyphase type. The only direct-current generator in the plant is used for supplying power for variable speed motors in an adjacent factory. At present a 400-kw. Westinghouse-Parsons turbo-generator forms the largest unit in the plant. It has been in operation for about five months and carries the entire evening and night load from 5 p. m. to 3 a. m. During the remainder of the 24-hour day's run, two Stanley inductor generators are employed, these being of 180 kw. and 125 kw. capacity respectively, the one driven by a 18-in. x 30-in. x 16-in. Westinghouse compound engine and the other by an McIntosh & Seymour tandem compound engine. Both of these outfits are of the belted type.

Steam is furnished at 125 lbs. pressure from an 875-h.p. plant located in the adjacent half of the station building. Water-tube boilers of B. & W., Heine and Caldwell types are employed; also one 70-in. horizontal return tubular boiler which supplies steam to auxiliaries. An 8-in. steam main extends from the most distant battery in the boiler room to the last unit in the engine room, where it joins the second main connecting all engines with the first three batteries of boilers. Valves in the various sections of the steam main provide a suitable flexibility in the operation of the boiler plant.

Provision has been made in the plant for the use of superheated steam in the turbine equipment. For this purpose an independently fired superheater has been installed in the boiler room and connected to the 8-in. main steam line, in such a manner that by opening and closing certain valves all steam coming from the boilers may be deflected through the superheater, where its temperature may be raised to any desirable degree, the steam then proceeding to the turbine. Or if it is not desired to use the superheater it may be by-passed and saturated steam furnished to the engine and turbine alike. The superheater is of the type supplied by the Power Specialty Company. Its construction differs somewhat from the U-pipe used in the Schmidt system and by some American boiler makers, in that the superheating surface is supplied by numerous radial ribs cast upon the periphery of a number of round cast-iron pipe sections arranged in a zigzag fashion within the superheater setting. Flat grates are used and the same grade of coal is burned in the superheater as in the regular boiler furnaces.

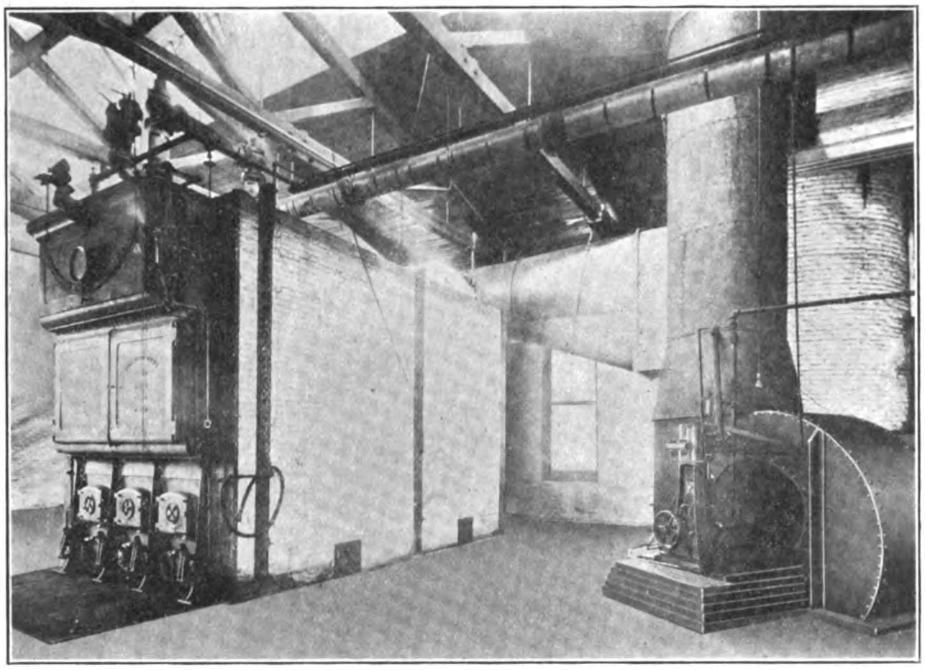

FIG. 2.—PORTION OF BOILER ROOM, SHOWING MECHANICAL DRAFT OUTFIT.

Draft is furnished by a brick stack into which lead sheet steel smoke flues from the various boiler settings. An American Blower Company mechanical draft outfit is also available for use during periods of heavy load and assists the main stack by drawing from the main flue a portion of the burned gases, discharging them into an auxiliary steel plate stack standing near the main stack. The fan intake is controlled by a butterfly damper located at its junction with the main flue. Coal is brought to the station upon an elevated track connecting with the lines of the West Shore and Erie railroads, which pass very close to the station. At present hand firing is employed.

The turbo generating unit was installed under pressure of necessity owing to the lack of sufficient floor space in the engine-room for the installation of an additional engine-generator outfit of suitable capacity. Since the plant was started the distributing system has rapidly increased both in point of area served and in aggregate load, and the plant forms an interesting example of the gradual tendency of engineering practice towards the use of more compact machinery.

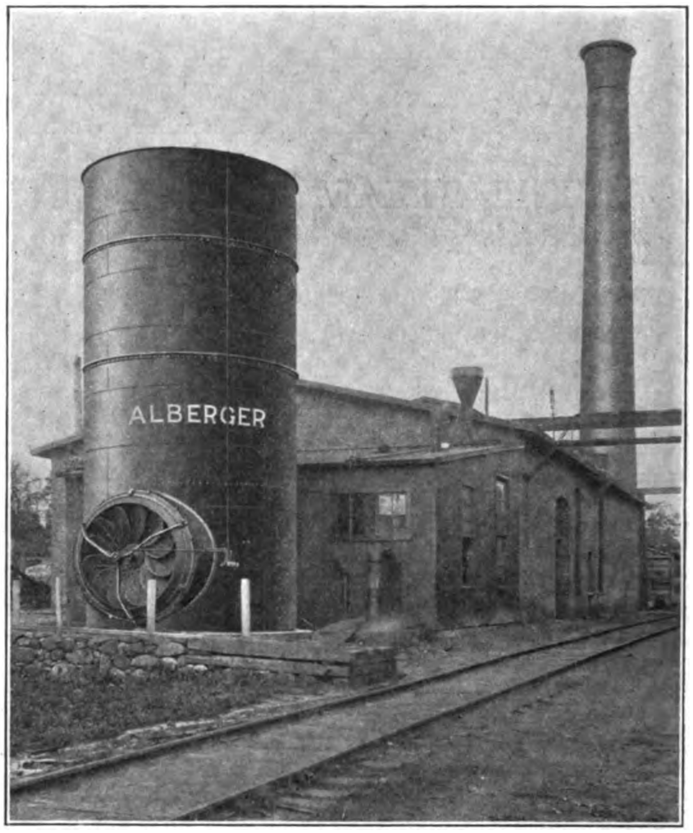

FIG. 3.—EXTERIOR OF STATION, SHOWING FAN-DRAFT COOLING TOWER.

The first outfit installed was the tandem compound horizontal engine belted to its generator; for the second outfit a vertical compound engine was installed, also belted to its generator; and for the third outfit, the direct connected turbo-unit, which occupies about one-tenth of the floor space required for the tandem compound belted unit.

The usual practice in turbine plants is to employ surface condensers in order that the condensed steam may be returned directly to the boilers, thereby avoiding the cost of water and also its purification in cases where mineral ingredients would cause boiler encrustation. At this plant, however, the feed water is drawn from a stream which passes the power house a short distance away, and as the water is comparatively pure, the condensing system operating the plant previous to the installation of the turbine was retained. This consists of an Alberger jet condenser with direct-acting air pump. The outfit is capable of maintaining a vacuum of 25 in. to 26 in. of mercury referred to a 30-in. barometer with the usual range of temperature of injection water. Outside of the engine-room is located an Alberger fan-draft cooling tower, which during normal operation of the plant serves the jet condenser. The fan shaft extends through the wall of the engine-room for the purpose of housing the belt-drive from a small Westinghouse Junior engine. This engine is also belted to a centrifugal pump set in a concrete pit just below the normal water level of the cooling tower well which supplies injection water to the condenser. In this position the pump never needs priming when being started. Exhaust steam from engines and auxiliaries is conducted to two heaters, one a primary and the other a secondary, and valves in the various exhaust lines provide complete control of the temperature of the feed. When the engine exhaust is greater than necessary for heating the feed water, a relief valve enables the excess steam to escape to the atmosphere. The turbine is also provided with an atmospheric relief in case of loss of vacuum.

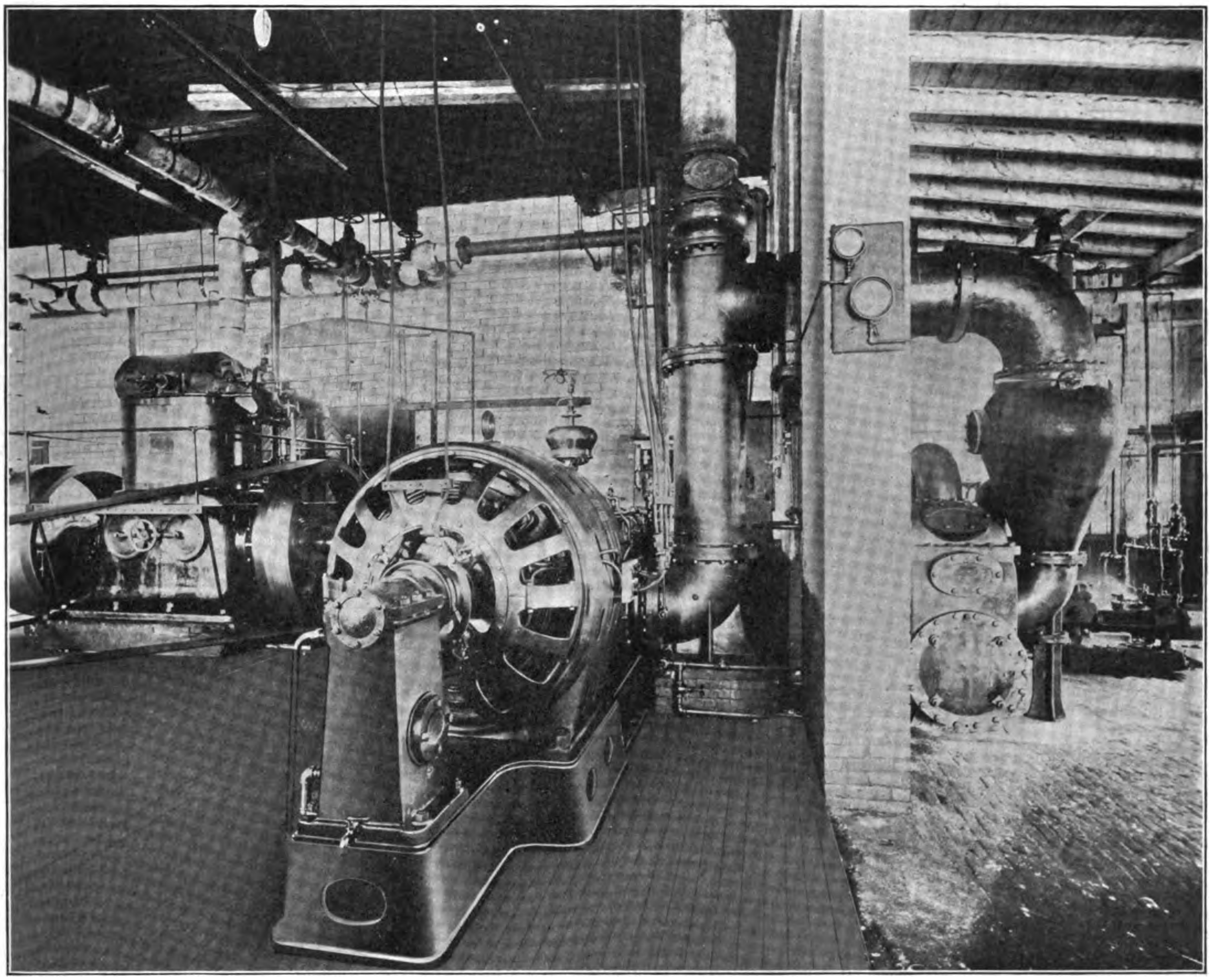

FIG. 4.—VIEW OF ENGINE ROOM, SHOWING TURBINE AND ITS CONDENSER.

The operation of the turbine up to the present time indicates in a striking manner what may be accomplished under unfavorable conditions. It is well understood that a high pressure and vacuum is desirable for use with a turbine on account of the increased economy derived therefrom. This increase of economy is greater than that which would be derived from a piston engine operating under the same conditions, and the greater investment in condensing machinery suitable for high vacuum is no doubt profitable in the case of the turbine. It is not, however, usually understood that the parallel flow type of turbine can operate with good efficiency under conditions of low vacuum and steam pressure such as obtain in this plant. Official tests conducted in the testing department of the Westinghouse Machine Company at Pittsburg indicate the general good economy of the turbine under these conditions:

Boiler Pressure, lbs.	Quality of Steam, %.	Vacuum ref. to 30-in. Bar.	R.P.M.	Brake Horsepower.	Steam Consumption, lbs. B.H.P. Hour.
126	1.0015	26	3536	580.	15.41
125	.999	26	3555	457.2	16.36
131	.999	26	3545	326.	17.89

During the test the steam was maintained approximately dry by means of the superheater installed in the testing department, in which the steam coming from the boiler plant was superheated just sufficient to re-evaporate the moisture contained. Its quality was determined by a throttling calorimeter.

The vacuum was measured by a mercury column and subsequently corrected upon a basis of 30 in. of mercury, which is used as a datum in all comparisons of turbine performances under different vacua. Brake horse power was measured by a special water absorption brake direct connected to the turbine and arranged as in the case of the ordinary Prony brake. At full load the turbine showed a steam consumption of 15.4 pounds per horse-power, which is equivalent to about 14 pounds referred to steam engine indicated performance. At a little over half-load the consumption had only increased to 17.89, or about 16 per cent, which is much lower than the corresponding increased economy in the piston engine, which amounts to more nearly 25 per cent. It should be borne in mind that this turbine although tested under low vacuum and steam pressure, was designed for 150 pounds pressure and 27 in. to 28 in. vacuum, as these conditions, it was anticipated, will ultimately prevail in the plant at Orangeburg. In view of these facts, therefore, the economy is particularly good.

In the matter of general operation, the experience with this turbine has been particularly fortunate, no troubles of a serious nature having arisen since the turbine was first placed in service. At times when the superheater has not been in use the turbine has been supplied with wet steam, which occasioned for the moment a slowing down in speed until the slug of water had passed through into the condenser, when the turbine immediately regained its speed. It is interesting to observe that no harm has resulted from this entrained water.

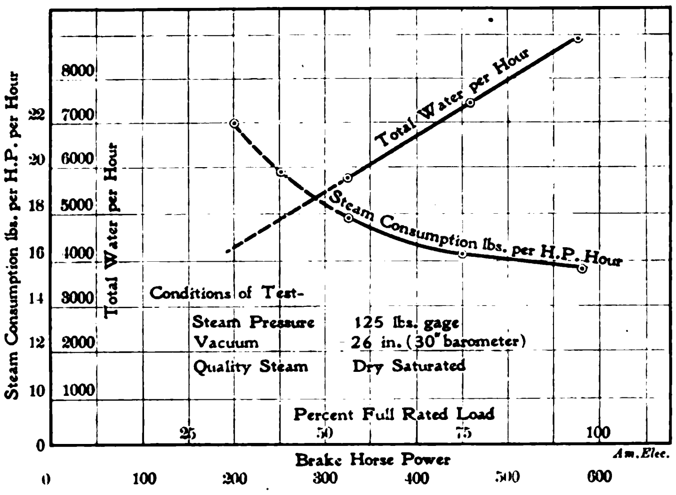

FIG. 5.—CURVE OF TURBINE PERFORMANCE.

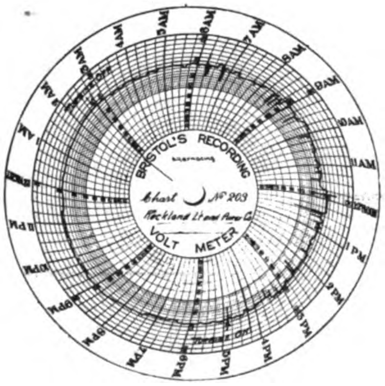

FIG. 6.—VOLTMETER CHART.

The great uniformity of rotation of the turbine is well demonstrated in the Orangeburg plant in the matter of voltage regulation. Up to the present time it has not been attempted to operate the engine and turbine units in parallel, as the switchboard is so arranged that the high voltage feeders leading to the various distributing centers may be switched over from one machine to the other, according to which machine happens to be in operation. It is, however, noticeable at distant points that the voltage regulation of the turbine is a large improvement over that of the engine equipment. This is shown in a striking manner in the accompanying recording voltmeter chart which was taken at Nyack, several miles from the power station. The turbine was put in service at 5 p. m. and continued until 3 a. m. on the following day, while the engine equipment continued through the balance of the twenty-four hours. It may be noted that the excessive fluctuations in a voltage of a more or less instantaneous character which are noticeable on the chart are largely due to induction motors which are connected to the system during the day. The gradual changes in voltage, however, may be traced directly to the regulation of the engine equipment. The circuit voltage is regulated from the switchboard through Stillwell regulators. One of these is placed on each phase of the two-phase circuits. By means of a chart, consisting of a straight line curve, the ordinates for which represent voltage and the abscissas current, the switchboard attendant is enabled to tell at a glance what voltage is required to compensate for the drop in the circuits.

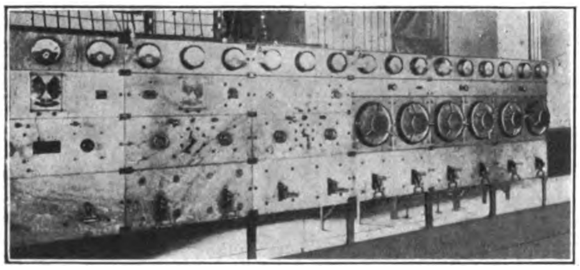

FIG. 7.—SWITCHBOARD.

The Rockland system is in charge of John S. Avery, general manager.

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ELECTRICITY ON STEAMSHIPS.

BY E. N. PERCY.

Lately several companies have specialized in the manufacture or design of electrical plants for steamships, but there is a larger field for progressiveness here than most electrical engineers realize, and it would seem that designers of marine machinery are not familiar with the possibilities of electricity in this field except in a general way. Some of the companies just referred to buy their dynamos ready made and couple them to cheap single-cylinder engines of more or less flimsy construction. The ship is fitted up with cheap switches and instruments, small poorly-insulated conductors, and there is no special protection against salt water or weather or the working of the ship. Moreover, this apparatus is likely to be installed by inexperienced men or the engineer's crew who have no special electrical knowledge. On the other hand, in the best passenger boats and in the United States Navy ships some very fine plants have been installed.

Applying electricity to any purpose on a ship involves many peculiar problems, some of which are as follows: Foundation or bed-plate flanges and bolts must be designed to withstand the pitching and rolling of the ship, even to the extent that they will not fall out if the ship capsizes, for many a good ship is rescued after "turning turtle."

The motions of a ship will transfer a rapidly rotating armature from one plane of gyration to another, introducing extra strains on the bearings and armature itself. This effect can be studied by whirling a weight on the end of a string and suddenly trying to change the plane of rotation.

The electric plant must be compact in all its parts, take up as little floor space as possible and at the same time be accessible. It must not be any higher than necessary and the center of gravity should be as low as possible. The engine must not throw oil and the generator must be protected from oil drips, salt water and sweat from the ceiling; it may even be placed where the main engines can throw oil or water on it. There may be lots of coal dust around, or the atmosphere may be kept damp by leaky steam joints. The steel hull of the ship or proximity of some of the beams may affect the magnets, or a hot steam pipe may touch some insulation.

Conductors of differing potential must not be run together. One of the most frequent causes of trouble is the breaking or shearing of conductors by the working of the ship. They must be given plenty of length and all armor or mouldings screwed or mortised at the ends to keep them from shearing. All connections must be carefully soldered, as corrosion is rapid in the salt air. Where lights are required in places exposed to the weather, they are covered by hermetically sealed globes. Sockets must never be exposed to weather. All outdoor switches and plugs for portables must be watertight. All conductors must be as flexible as possible and heavily insulated. Wherever conductors pass through bulkheads, there should be bushings of ebonite or rubber, never porcelain. These bushings or sleeves must in some way take hold of the armor or moulding to prevent shearing.

Grounds are more serious than in land practice. Besides the danger of fire, powder explosions or short-circuiting, the effect of electrolysis upon the ship's structure is very dangerous. A ground of a few weeks' duration may seriously weaken a spot in the ship's structure, or eat through some important pipe. Portable interior lights may be connected up with ordinary lamp cord, but no swinging lights are allowed, as they short-circuit in a few weeks at the upper end of the cord. In a metal ship it is almost impossible to prevent grounds without first-class work.

Lamps of 8 and 16 candle-power are favorites for staterooms and crew's quarters. Larger units are used on the decks and in chandeliers. Most steamships nowadays are provided with searchlights. These are often 50-volt lamps worked on a 110-volt circuit in series with resistance coils. How much better it would be to install two searchlights and run them in series. A cable runs up the forward mast to the mast-head light and to others at times for signalling purposes. These cables should be carefully armored and connected, as they often ground or shear off, especially on steel masts. Colored lights are placed on each side in accordance with law, a white light being placed inside a water-proof lantern.

Motors are in general use for ventilation and to some extent for hoisting purposes, but for little else. It is perfectly possible, and would result in many advantages, to apply them to forced-draft blowers, pumps, jacking gear, etc. Scarcely a ship comes in that does not require repairs to her forced-draft engines. These engines run from 400 to 1000 r.p.m., and one cannot escape the impression that it is the engine instead of the draft that is forced. These engines frequently go to pieces and use enormous quantities of steam. An electric motor would stop all of this waste and repair. No machine on board ship gives more trouble or is more wasteful than the pumps. Electricity has been successfully applied to the driving of every known type of pump. Lately, the wonderful success of compound turbine and propeller pumps and centrifugal pumps indicates that soon these pumps will be used for pressures of any height, and they are eminently well adapted to be driven by electric motors. These can be used for boiler feed, main air pumps, fire and bilge pumps, and all other purposes. Refrigerating machinery is easily driven by an electric motor, and the turbine principle can be applied to air and ammonia compressors in time. It can be applied to the operation of large ice cream freezers, chopping machines, baking machinery, etc. Deck motors are made watertight, as are also their controllers and switches. They are used for cargo hoisting, working boat davits, coal derricks, and opening or closing bulkhead doors.

Electrical auxiliaries present many advantages. They do away with the auxiliary steam piping now necessary; having a concentrated source of power, they are compact; the repair bill is much smaller; they can be run by current from the dock when in port; they can be started instantly without draining pipes or warming up engines. In the case of a ship provided with water-tight motors, if that ship sank and were repaired by divers she could be pumped out by her own pumps, taking current from another steamer.

Storage batteries are not of much practical good in a ship, except in very small plants. Telephones, bells and speed indicators all play a part in a vessel's make-up. The commercial efficiency of electric heaters is an open question. Their only advantage is the doing away with steam pipes.

So far, most marine plants are of the direct-current type. Alternating current offers, possibly, some advantages which the marine engineer has yet to have made clear to him. It might obviate some direct-current troubles, such as electrolysis.

Electrical engineers have lately evinced some interest in the marine plant problem, and it is hoped their efforts will bring forth good fruit.

MANUAL VS. AUTOMATIC TELEPHONE EXCHANGES.

BY HOWARD S. KNOWLTON.

In considering recent progress in telephone engineering the writer is drawn to the conclusion that a large amount of time and money has been expended in developing the so-called automatic exchange. Inventors have for several years worked hard to bring out a system which will stand the test of commercial operation, and their painstaking efforts to advance the art of communication by telephonic means deserve great credit. The operation of the new exchange at Grand Rapids, and at other cities where automatic systems have been installed, will be watched with great interest by telephone engineers and superintendents, and the test of time ought to make comparisons possible which will determine whether the new systems shall stand or fall.

At this time, however, it is important to recognize the disadvantages of any new system quite as much as its advantages. It is better to go slowly than to hasten to adopt untried systems and repent because they do not come up to the standards demanded by an exacting and not always reasonable public. It is not the purpose of this article to declare that automatic telephone exchanges have no place in the signalling world, nor is it the writer's intention to affirm the everlasting superiority of the manually operated systems. Rather, it is desired to point out the somewhat rigid requirements of service which the automatic exchange must meet if it is to hold a firm position in telephone practice of the immediate future.

It is certain that some of the automatic apparatus which has lately been brought forward is remarkably ingenious in its details, and on cursory examination appears, as far as the central office is concerned, to be able to stand up under continuous service without going to pieces. Parts are in duplicate, rugged in construction, and logically arranged. But technical success does not necessarily mean commercial success, although it is always an essential feature of the latter.

The greatest advantage claimed by the advocates of the automatic system is the elimination of subscribers or "A" operators, whose wages necessarily constitute a large factor in operating expenses. The argument that this elimination does away with the possibility of strikes and similar labor troubles among these operators does not strike one as powerful. Telephone operators are not sufficiently unionized to make this a formidable consideration.

In the strictest sense the automatic telephone exchange is not automatic after all. A telephone conversation between two subscribers involves an unavoidable process of selection in establishing a connection between them. In the manual system this selection is made by the "A" operator, and in the automatic system the work falls upon the subscriber. From the operator's standpoint, which in some ways is more important than the technical, it is a serious thing to throw upon the subscriber or casual telephone user the slightest amount of work beyond taking his receiver off its hook and asking for the required number. The whole trend of telephone practice has been toward greater simplicity in the subscriber's station and its operation; witness the replacement of the magneto generator and local battery by the common-battery central-energy exchange. The first cost of this has been very high, sometimes a thousand dollars per foot in the central office multiple switchboard alone, but the reduced maintenance charges and increased satisfaction on the part of the subscriber have gone a long way toward justifying the change. It is hard to estimate the betterment of service produced by enabling the subscriber to call the central office by simply removing the receiver from its hook, as compared with the old method of grinding out signals through a sometimes cranky magneto. One cannot imagine anything much simpler than this from the subscriber's standpoint.

The automatic system requires the subscriber at least to set up the number which he wants by means of pegs, pins or cranks, and in some cases he is obliged also to ring up the other party to the conversation. These operations are simple enough to persons accustomed to accuracy, but it is another proposition to expect the public at large to grasp the sequence of operations and correctly to manipulate the delicate apparatus of an automatic system each time it talks by telephone. It is true that the annoyances occasioned by operators' mistakes, flippancies and thoughtlessness are eliminated in local traffic by the automatic exchange, but it is possible that other vexations may occur. It is not difficult to imagine the trouble which it would be to a business man in a large city to have to put his mind upon solving the puzzle of setting up numbers himself at some crisis of his affairs when every moment is of great value and every faculty of his mind required to be at its highest efficiency. Here is a chance for the most decided annoyance to enter, and if the private branch exchange be cited as a remedy it only removes the trouble a step further. Perhaps the most important function of the telephone lies in its time-saving qualities, and in the case of a subscriber who wants a large number of numbers in sequence, the inconvenience of setting up all these numbers himself, and probably ringing them up as well, is no imaginary burden.

Again, it is doubtful if a great public service system like the telephone exchange can be entirely reduced to machine methods with the ready acquiescence of the public. Human nature is at each end of the line, and conditions are bound to arise where something more intelligent than machinery is needed to straighten matters out. Thus, in a conversation through an automatic central office the transmission may be imperfect and cannot be remedied without the delay of an appeal to the wire chief, whereas it might be possible for an operator in a manual exchange to suggest effective remedies or notify the trouble man at the very moment the difficulty was noticed. No mere machine, however intricate or wonderful, can possess intelligence, and that quality is one of the most vitally important characteristics of an efficient operator. An illustration of the public's attitude toward this is found in the antipathy which was shown to the use of the graphophone to inform a calling subscriber that the line sought was busy. This monotone repetition of the words, "The line is busy, please ring off!" became so annoying to the public that the telephone companies are lately substituting other means of imparting this unwelcome information.

Another step which at first blush looks like a backward movement is found in the increased complication of apparatus at the subscriber's station. This means increased cost of repairs, not only for labor and material, but in time expended and in money paid out in traveling from station to station when the instruments get out of order. This increase in the maintenance item must certainly be considered as an offset in some degree to the reduction in operators' wages occasioned by the installation of the automatic system. In other classes of telephone service the reduction in maintenance expenses caused by the removal of batteries and magnetos from the subscriber's station has been great indeed, and any progressive company will hesitate a long time before doing anything to increase this kind of expenditure. Again, the writer is advised that the outside wire plant in some systems requires not only a separate service from the office to each subscriber, but three wires instead of two to each station. This means heavy extra expense for overhead circuits, aerial and underground cables, conduits, etc., to be considered in its relations to the saving in operators' wages.

As far as the claim of superior secrecy in the automatic system goes, there is just about as much chance of cross-talk occurring between the outside lines of one system as the other. While it is true that an operator at a central office can "listen in" on a conversation by pressing a key on the keyboard in front of her, it is also true that in an office where business is properly proportioned between different switchboard positions an operator has very little time in which to regale herself with the conversations which pass over her cord circuits. The same claim would fall as flat when applied to the service given by a telegraph company. Any employee of a company transmitting messages as a business who divulged the nature of such messages would speedily find himself or herself in serious trouble. Complaints that telephone service is not secret in a manual system are about as trivial in actual practice as can well be imagined and almost always indicate the ignorance of the complaining party as to the real operating conditions in the exchange which serves him.

The service requirements of different communities vary widely. It is difficult to see how an automatic system can satisfy any others than flat rate, and possibly some few measured service, customers. Some communities are entirely contented with unlimited flat rate service, but others want every variety of contract which ingenuity can devise. The problem of "nickel service" would still further complicate the subscriber's station, and it certainly does not appear easy to fit it to an automatic system so as to insure successful operation without an operator at "central" to oversee the process of establishing and paying for a connection.

In the automatic systems, pay station service of the class originating in hotels, drug stores, saloons, etc., must with little doubt be handled by manual operators. Toll traffic over long-distance lines cannot be handled by mere machinery alone. It is a question whether calls from pay stations can be handled as rapidly in a system which is partly manual and partly automatic as in a purely manual system, where the pay station lines terminate in easy reach of the multiple jacks of all local subscribers connected to an office. It would appear that ceaseless vigilance is as necessary to keep an automatic system in repair as to hold a manual board up to the work of good operation, and outside the central office there is little room to doubt that it is a much harder task to maintain the automatic system in first-class condition.

A strong point of automatic telephony is said to lie in its freedom from interruption. The mechanism is designed to allow absolutely no interference while two subscribers are talking. This, however, is by no means an unmitigated blessing. Occasions often arise when it is most important that a conversation be temporarily discontinued. For instance, a long-distance call for a local subscriber may enter the office while that subscriber is talking with another local line. After a reasonable time of waiting, it is desirable that the called local subscriber be informed that a long-distance connection wants him, and if it is impossible for a courteous interruption to be made the service will be rendered poorer all around for that reason.

Great inconvenience arises at times in an automatic system from the fact that numbers have to be set up visually. It is difficult to use such a telephone in the dark. Even if the subscriber knows the required number without consulting the directory, it cannot be rapidly and accurately set up without some sort of illumination on the instrument.

It will be a satisfaction to the writer if the advocates of automatic telephony in large exchanges will publish the results of operation in the cities which have been bold enough to try the new systems. Every telephone engineer would appreciate full information as to first cost, maintenance, depreciation, and the method of overcoming the obstacles specified herein. The telephone world naturally wants the best apparatus which can be produced, and if the automatic systems prove superior to the manual, it will not be through concealing their data. In few branches of engineering would the publication of reliable data be productive of greater good. It may as yet be too early to determine the future status of automatic telephony, but it is certain that until the difficulties here suggested are overcome there is little chance of the manual systems being superseded. That the best system may ultimately triumph is the desire of every broad-minded student of telephone engineering.

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CLEANING STEAM BOILER SURFACES.

BY R. T. STROHM.

The effect of scale in lowering the efficiency of heat transmission through the plates and tubes of steam boilers seems to be grossly exaggerated, if one may judge by the statements made concerning this point. According to some writers, the presence of scale to a depth of one-sixteenth of an inch causes an increase of 15 per cent. in fuel consumption. This means that if scale should collect to a depth of seven-sixteenths of an inch, the fuel consumption would be doubled. Unfortunately, these figures cannot be substantiated by actual experience, and a reasonable doubt prevails as to whether the loss due to scale is anywhere nearly as great as some writers would make it.

However, while opinions may differ markedly as to the exact amount of loss occasioned by unclean heating surfaces, steam boiler users are unanimous in declaring that scale does lower the boiler efficiency. And further than that, it endangers the safety and shortens the life of the boiler because of the overheating of the plates at those points where the scale lodges thickest.

In order to clean the shell of a return tubular boiler which is badly scaled, it is necessary to remove the manhole covers and enter the boiler with hammer and chisel, or with wire brush and scrapers, to remove the incrustation to the best advantage. This is always a tedious and disagreeable piece of work, and it is small wonder that it is so often neglected. The usual method of procedure in cleaning a boiler of this type is to open the blow-off and start the feed-pump, maintaining a fairly constant water level until the boiler is cooled down considerably. Then all water is drawn off and the manhole and hand-hole plates removed. After air is once admitted to the boiler, the cleaning should be carried on as rapidly as possible, for most scale solidifies quickly upon exposure to the air. If the boiler has a manhole at the top, it is often found convenient to remove it and to enter the boiler at this point, scraping the scale from the shell by using stiff wire brushes and lowering the water level slowly at the same time. This prevents any contact of the air with the scale, and thus prevents the hardening referred to previously.

The above method is mechanical only in so far as it requires the use of mechanical appliances. A novel form of mechanical cleaning, obviating all manual labor in chipping off the scale, was brought out and patented in England some years ago. This method was simply to use a small refrigerating system, producing inside the boiler a very low temperature, which served to render the scale brittle and caused it to chip or flake off, owing to the difference in coefficients of expansion of iron and of scale. The refrigerating apparatus consists of a small ammonia compressor, and a number of expansion coils which are placed within the boiler. The interior is then subjected to a temperature close to zero. The expansion following the removal of the coils, as the boiler returns to the normal temperature, assists in removing particles of scale which the contraction has only loosened. This process, however, would scarcely be a very practical one except in refrigerating plants.

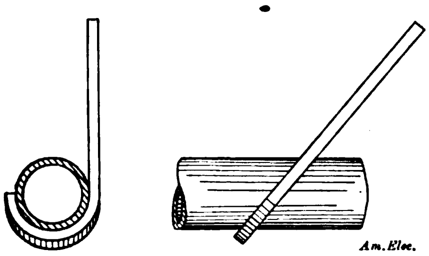

FIG. 1.

While it is comparatively easy to clean the plates of a return tubular boiler, the matter of removing incrustation from the fire-tubes is not so easy, unless the proper tools are at hand. Scrapers made of rectangular bar iron bent into a U at one end, as shown in Figs. 1 and 2, have been improvised, but they are not easily used, and do not remove the scale as perfectly as it should be done. As a consequence, a large number of boiler-tube cleaners have been placed on the market, their object being to lessen the labor and the time required to clean tubes satisfactorily.

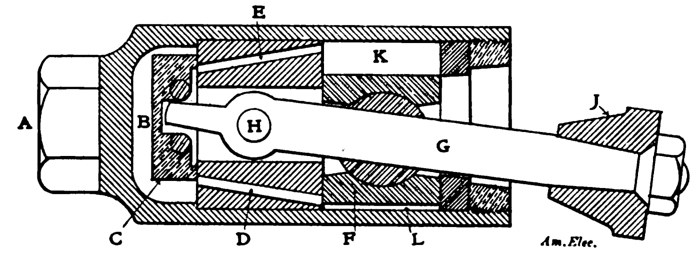

FIG. 3.

The principles of construction of these cleaners vary widely, according to the types of boilers in which they are to be used, and depend also upon the nature of the cleaning which they must perform. Consider first the cleaner required to remove scale from the water surface of a fire-tube, as in a return tubular boiler. Such a cleaner is illustrated by Fig. 3. It consists of an outer cylindrical casing having a nozzle at *A* for the admission of either compressed air or steam, whichever is the more easily obtainable. Inside the nozzle is a chamber, *B*, in which is a small slide-valve, *C*, without lap, which moves diametrically across the seat containing the ports *D, E*, alternately opening and closing them. These ports lead to opposite sides of a piston, *F*, which also moves diametrically back and forth across the cylinder under the pressure of the fluid admitted through the ports. A lever *G*, carrying at its outer end a hammer *J*, is pivoted on a pin *H*, fixed in the casting containing the ports. The other end of this lever moves the slide-valve *C*, while at the middle it passes loosely through a steel sphere which makes a ball joint in the piston *F*.

The action of the device is very simple. Supposing steam to be admitted to the chamber *B* with the parts in the position shown, the steam would pass through the port *D* into the clearance space *L* and force the piston *F* to the other side of the cylinder. This motion would be very swift and would cause the hammer *J* to deliver a quick, sharp blow against the inner surface of the tube. However, the motion of the piston *F* in the direction of clearance *K* causes the slide-valve *C* to move in the opposite direction. This closes the port *D* to the live steam and opens it to the central exhaust passage, and at the same time opens the port *E*, admitting live steam to the chamber *K*; the piston *F* and the hammer *J* are thereby forced back to their original positions, the latter striking a blow against the tube opposite the previous point of impact. The rapid motion of the hammer, which may reach 1500 vibrations per minute, subjects the tube to repeated shocks, the blows being at no time of sufficient strength to hurt the tube, provided it is sound, and yet capable of cracking the brittle scale and jarring it loose from the water surface of the tube. If, on the other hand, the tube is thin owing to corrosion, or burned, so as to be weak and unsafe, then the blows of the hammer are likely to reveal the defect, which should be known.

This cleaner-head is attached to the end of a pipe of sufficient length to enable it to be pushed from one tube-sheet to the other, the pipe serving also to convey the steam required for operating the device. Owing to the inaccessibility of the tubes in a return tubular boiler, with the exception of the upper and lower rows, the hammer cleaner offers practically the only solution to the problem of removing scale formations from the water surfaces of fire-tubes. The use of acid solutions to clean all interior surfaces has been advocated, but has gained little favor owing to the fact that the boiler materials may be corroded by the acid.

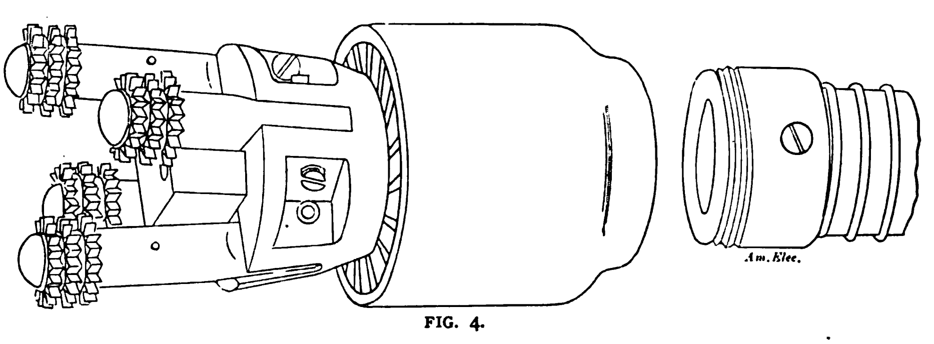

FIG. 4.

In the case of water-tube boilers, the scale formation occurs inside the tubes, and consequently a different style of cleaner must be used. It becomes necessary not only to remove it from the tube surfaces, but also to get it out of the way of the cleaner. The scale met with in water-tubes is frequently of a very hard and tenacious character and requires no small amount of force for its removal. As a result, three distinct methods of operating the cleaner have come into use. These are steam or air, water, and electricity. The principles upon which tube-cleaners act may be divided into two general classes—a cutting action and a hammering action. In the former, the tool is furnished with a number of cutter wheels, which are given a rotary motion inside the tube, or are forced along the tube in a longitudinal direction, while in the latter a hammering action is employed to break up and loosen the scale.

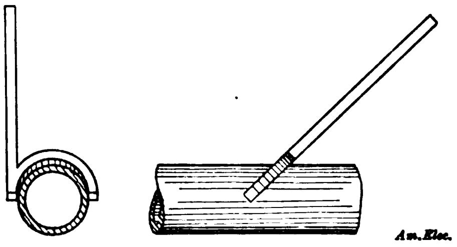

FIG. 2.

A good example of the class using a rotary cutter is shown in Fig. 4. It consists of a cylindrical outer casing in which is a small turbine, operated by water under 150 pounds pressure, or higher, the water being supplied through a hose connected to the coupling shown on the right. The turbine has ball bearings to reduce friction to a minimum, and rotates very rapidly. To it is fastened a spider of phosphor bronze, into which four steel arms are pivoted, these steel arms carrying hardened steel cutter-wheels. As the turbine revolves, the arms carrying the cutters are thrown outward by centrifugal force, and the sharp-toothed wheels cut the scale loose from the tube surface. The water discharged from the turbine flows out past the spider and the cutter-wheels and serves to carry away the scale as fast as it is loosened. Different styles of cutter-wheels are furnished with each cleaner so as to adapt the device to all kinds of scale formations.

Very often the scale is of such thickness and tenacity as to require more than ordinary efforts in its removal. In such cases an electric or a hydraulic motor or a small steam engine supplies the power necessary to operate the cleaner. A motor cleaner of this kind is illustrated by Fig. 5. The cutter-head consists of a steel casting having several recesses, into which are fitted a number of steel toothed wheels, free to revolve on their shafts. The rotation of the shaft to which the cutter-head is fastened throws the wheels outward, and they cut the scale loose, at the same time polishing the inner surface of the tube.

If the scale formation is thin, and the tubes are straight, it is possible to remove it by the use of hand cleaners such as those illustrated by Figs. 6 and 7. The former consists of four pairs of cutter-wheels set at the ends of four spring arms. This head is fastened to a rod, and is pushed from one end of the tube to the other by muscular effort. The latter form of cleaner, from which one arm is omitted to show more clearly the construction, has a sliding wedge which forces the cutter-wheels against the scale. It is evident that these two types require not only a large amount of manual labor, but that they are much slower than the turbine and motor types.

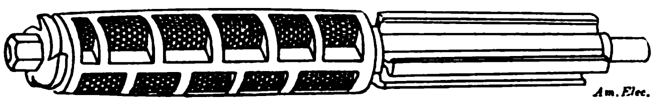

FIG. 5.

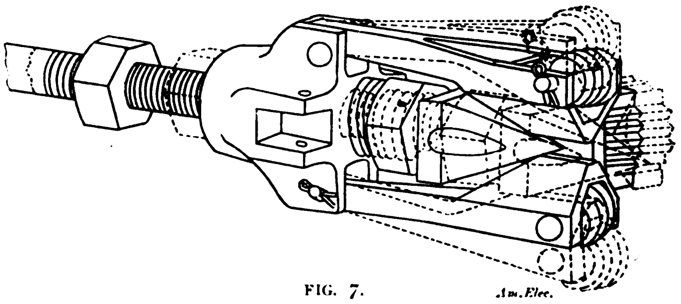

FIG. 7.

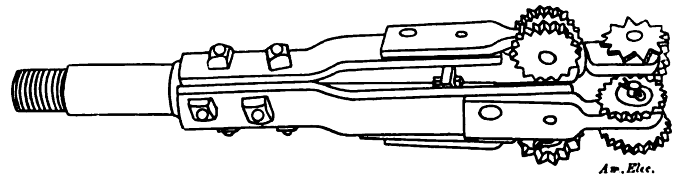

FIG. 6.

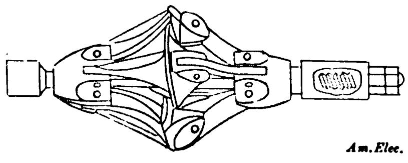

FIG. 9.

The second class of cleaners for water-tubes, using the hammer action, does not differ essentially from the one shown in Fig. 3. All that is necessary is to change the hammer-head on the vibrating shaft, using a sharper edge to cut the scale.

Incrustation on the water surfaces of tubes is not the only retarder of heat. The interior of fire-tubes and the exterior of water-tubes frequently become coated with soot and cinder, which are likewise poor conductors of heat. Consequently, any such accumulations should be removed as often as necessary to facilitate the transmission of heat and to increase the boiler efficiency.

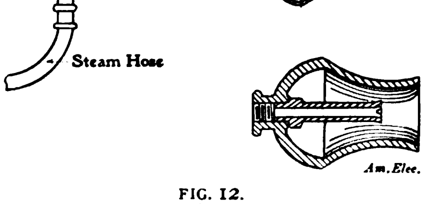

FIG. 12.

The cleaners in use at present for this purpose may be divided into four classes, viz., scrapers, brushes, blowers and suckers.

A very good idea of the scraper tube-cleaner may be obtained from Fig. 8, which shows a well-known make. It has four tempered steel blades, curved to a circular form so as to fit the tube, against the inner surface of which their cutting edges are held by the elasticity of the shanks. This scraper is attached to a long rod and is pushed from end to end of the flue. Fig. 9 illustrates another type of scraper, which possesses the advantage of being adjustable to fit tubes of different diameters. Adjustment is accomplished by turning the nuts at the end of the head, moving the blades further apart or closer together.

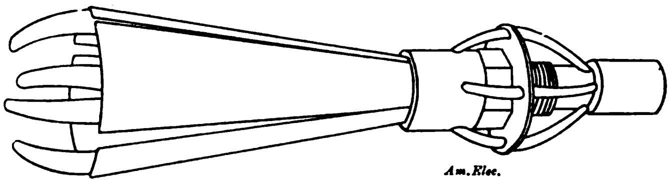

FIG. 8.

The common form of flue-brush is shown in Fig. 10, consisting simply of a helix of stiff wires interwoven with a heavy wire or iron center. This style of cleaner can be used to advantage only where the soot is dry and does not adhere strongly to the tubes. More often, therefore, it is customary to combine the brush and the scraper in one cleaner, as illustrated by Fig. 11. The scraper goes into the tube first, cutting loose the accumulations of soot and dust, while the brush follows and sweeps the surfaces clean. This combination of brush and scraper is made in a large variety of forms. The great objection to all cleaners of the scraper class is that their use entails a large amount of labor when the coating of dust is heavy.

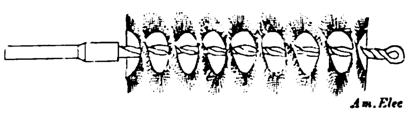

FIG. 10.

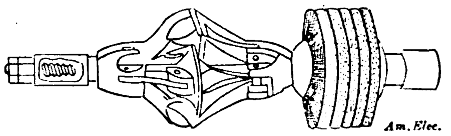

FIG. 11.

One form of blower cleaner for fire-tubes is illustrated by Fig. 12. It has a central steam nozzle of small diameter opening into a hollow head, which in turn is placed in the end of the tube. The steam blast, divided by the partitions at the tip of the nozzle, draws with it a large amount of air and this current of air and steam at high velocity is intended to clean the tube of all soot and dust. Another form of blower cleaner is shown in section in Fig. 13. It also uses a steam blast from a central pipe, which draws in an air current through a small conical nozzle, on the principle of the ejector. This ejector action is compounded by a series of converging nozzles and a large volume of air thus entrained with a small steam current. This blast of air is caused to impinge against the sides of the tube by an inverted cone placed at the outlet. The air thus issues in a thin annular stream, giving it a sort of knife-like action in removing the dirt. This cleaner may be pushed to any distance in the tube, assuring a clean surface throughout.

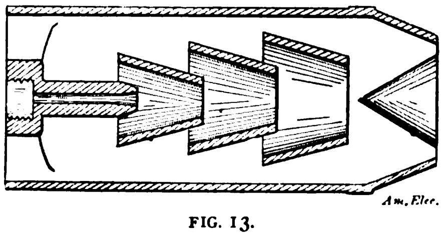

FIG. 13.

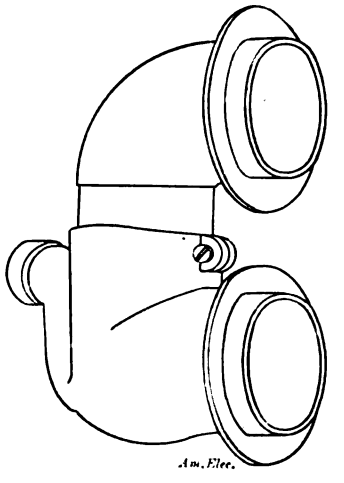

FIG. 14.

Some engineers object to admitting steam and air into the tubes. They complain that the steam condenses, making the soot and dust sticky, and causing it to adhere so tightly that a scraper is necessary to remove it properly. In order to overcome this difficulty, the blower shown in Fig. 14 was designed. It has two nozzles, one of which fits into each of two adjacent tubes. A steam jet in the lower nozzle draws the hot gases from the tube in which the upper nozzle is placed. These hot gases superheat the steam and prevent its condensation and at the same time furnish the volume of the blast necessary to clean the tube.

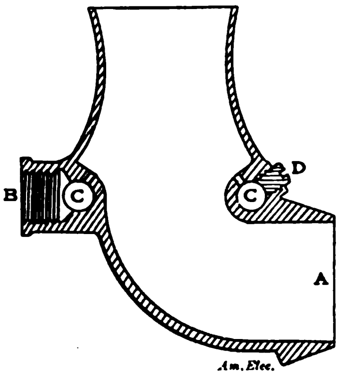

FIG. 15.

The fourth type of cleaner, working on the suction principle, is represented by Fig. 15. It is a cast-iron elbow having one end, *A*, tapered so as to fit into the tube to be cleaned, the other end, bell-mouthed, being pointed toward the chimney flue. Steam is then admitted, through a pipe connected at *B*, into the annular chamber *C*, which is pierced with numerous small holes pointing toward the outlet. In escaping through these apertures, the steam is wire-drawn to such an extent as to be superheated slightly, and its escape from the bell-mouth orifice induces a strong current through the tube into which the tapered end *A* is placed; this current of hot gases sweeps the tube clean of the accumulations of dust and soot. The soot thus sucked out of the tube is discharged at a high velocity into the chimney. The small plug shown at *D* is removed when it is desired to clean out the chamber *C* by blowing through a current of high-pressure steam.

The tubes of a water-tube boiler are cleaned externally by means of a steam blast. A cheap but effective form of cleaner for the Heine boiler is shown in Fig. 16, consisting merely of a round bar bent into a handle and attached to a long piece of wrought-iron pipe by a tee, the branch of which admits the steam supply. The end of the pipe is plugged, and eight small holes are drilled in the wall near the end. The water legs of the Heine boiler are fitted with a large number of hollow stay-bolts, through which the pipe is pushed, cleaning the tubes from end to end.

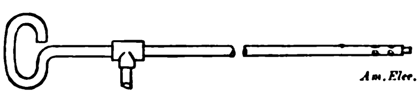

FIG. 16.

The tubes of many water-tube boilers are bent, and consequently their cleaning, internally, becomes considerably more difficult than the cleaning of straight tubes. In such cases it is necessary to use a boring head which will pass easily around a bend, and this means a short cleaner. Also, it must have a flexible connection with the operator. Several cleaners using motors as their source of power are provided with flexible shafts to transmit the power to the cleaner-head.

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TELEPHONE ENGINEERING.

Cable Terminals.

BY F. J. DOMMERQUE.

All cables must be provided with terminals at both ends. The terminals may be at the exchange building, in a subscriber's building, or upon a pole line. At this juncture the pole line terminal is of interest only. The older method of terminating the cable in a cable-head, consisting of an iron box screwed to the rear wall of a wooden box, is still in favor in many places. The construction of iron cable-heads differs in detail only. In general the cable-head is a rectangular cast-iron box with a removable front, as illustrated in Fig. 1. The cable enters the box from the bottom, the pot-head end of the cable being attached to a metal bushing in the bottom of the cast-iron head. Inside the head the conductors lead each to one end of a connector-pin, a row of which is inserted along both sides of the head, each pin being insulated from the metal by a hard rubber bushing. The outside end of the connector-pin is attached to or forms part of the lightning arrester and fuse, mounted upon the outside of the box. This kind of terminal is nearly always provided with lightning arresters and fuses, because it is used upon cable poles that form the transfer point from underground to aerial construction; in that case always a considerable quantity of open wire enters into each line, requiring protection against lightning and strong currents. These heads are built for 25 to 100-pair cables. The protective devices will be described in detail subsequently. The heads are encased in a terminal box attached to the pole.

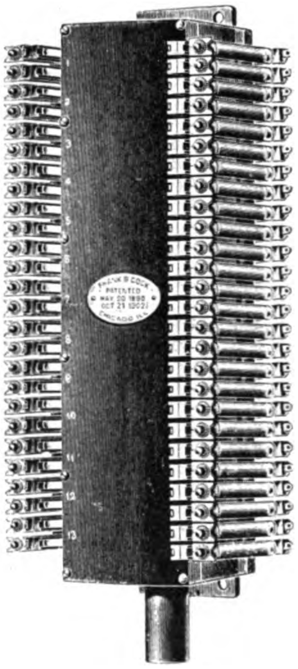

FIG. 1.—CABLE HEAD.

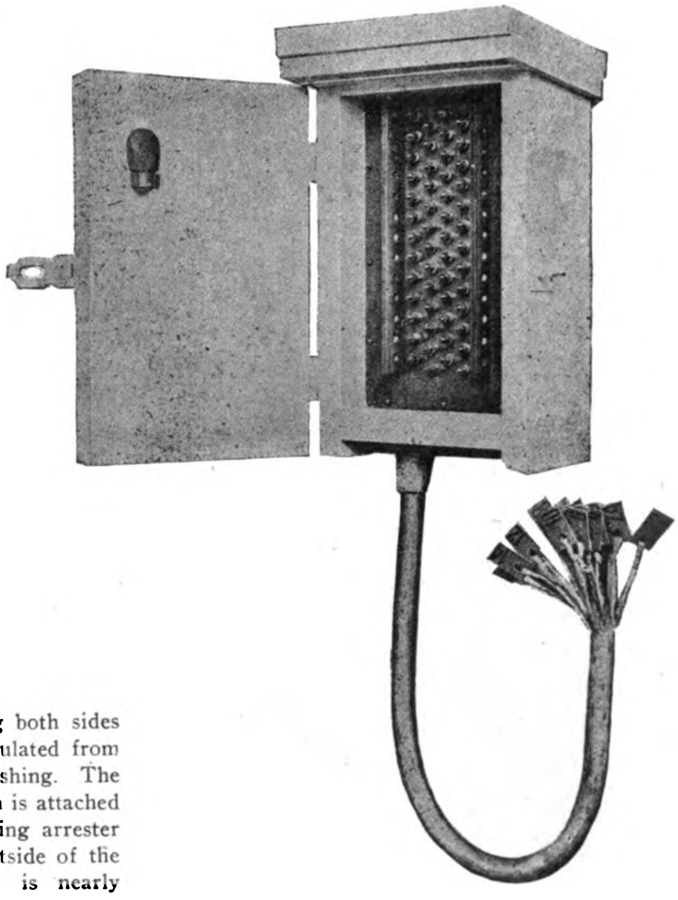

FIG. 2.—25-PAIR CABLE BOX.

In modern line-work open wires are mostly used for distribution only, except in very small plants and for toll and long-distance lines. When the cable terminates upon a distributing pole, which means when the cable is not continued in open line wires but opened in the terminal box and each pair of conductors connected to drop wires that lead directly to the subscriber's premises, the cable-box required can be of comparatively small dimensions, as such a cable will as a rule not contain more than 25 pairs and very often 10 pairs only. Not all 25 pairs will be used at this distributing pole, but all 25 will terminate there. In fact, at the beginning there should be quite a number of spare lines, in order to enable the telephone company to fill future orders for connection without disturbing the rest of the plant and on short notice. Just in this direction the economy of aerial cables with respect to open wires will be appreciated most. Not only that for the same first investment a greater number of lines can be provided in a cable than in open wires, but that any extension up to the full capacity of the cable is so very much cheaper. As the drop or service wires from the distributing pole to the subscriber's premises are short and not exposed to atmospheric discharges and high-tension currents, lightning arresters may be dispensed with altogether at this end of the line, provided there are arresters at the switchboard end of the line. In this case, the cable terminates in a pothead which is held in the bottom of a wooden box, the rubber-covered wires from the pothead extending to binding posts inside the box. Fig. 2 illustrates such a box for a 25-pair cable. It will be noticed that there are 26 pairs of binding posts provided; the twenty-sixth pair is for the extra pair in the cable. The box itself is made of 1¼-inch dressed kiln-dried lumber (cypress), sides, top, bottom and door, each made out of one piece; the top is made double, or single and covered by a piece of well-painted galvanized sheet iron. The box must be painted inside and outside with two coats of pure white lead and oil; the inside may also be treated with a flame-proof insulating compound for the protection of the cable, or lined with asbestos. The top should be projecting and slanting for the rain to run off. On each side of the binding posts is a fibre or wood panel with holes for the jumper-wires which are run down in a hand-made cable through holes in the bottom of the box and thence to the insulators upon the distributing fixture, which may be a cross-arm or a ring. Fig. 2 shows the box fitted with a flange funnel and a short piece of cable for connection to the main cable; this piece of cable is furnished with the box and saves time and trouble for the lineman. When this short piece of cable is connected to the main cable by a Y-splice, it should be given a dip in which any moisture that may come in from the terminal box may collect. Fig. 3 shows a connection of a terminal box to a main cable. The binding posts in the box should always be numbered; the numbers may also be located upon the jumper panels, and it is recommended to have a record card attached to the inside of the door on which a record is kept of all changes in the jumpering.

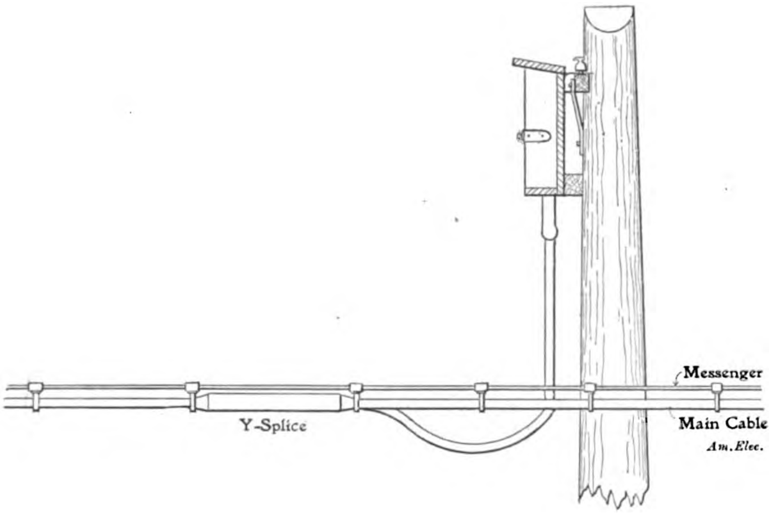

FIG. 3.—MAIN CABLE CONNECTION TO TERMINAL BOX.

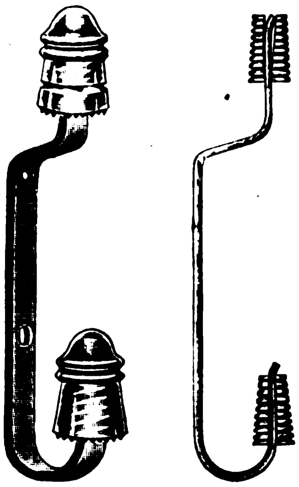

FIG. 6.—BRACKET.

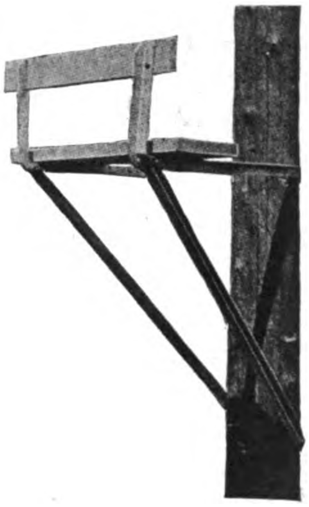

FIG. 8.

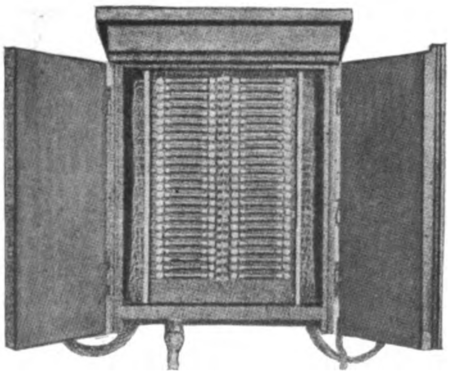

FIG. 4.—TERMINAL BOX.

Where long aerial lines are connected to the cable, lightning arresters and strong current protectors or fuses are required, the same as in the old iron cable-heads. Nowadays mostly wooden boxes, similar to the one just described, onlv larger, are used. Fig. 4 shows such a box wired up. The lightning arresters are in the center, the tubular fuses on each side of them, and the jumper-wire panels at the two sides.

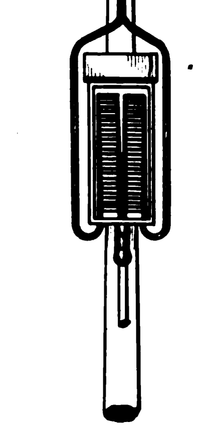

FIG. 5.

In all terminal boxes the cables enter and leave from the bottom. The jumper-wires for 25-pair and larger cables are usually divided into two hand-made cables and run outside the terminal box to the cross-arms in the manner shown in Fig. 5. In this figure the pins on the cross-arms are numbered consecutively; they may be numbered also from 1 to 25, giving two adjacent pins the same number in correspondence with the numbering of the pairs of conductors in the cable.

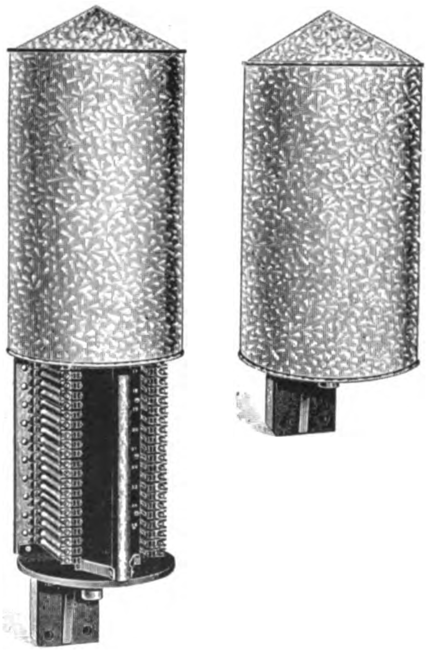

FIG. 7.—TERMINAL BOX.

In the illustration last mentioned, distribution from the terminal box by means of cross-arms is shown; such distribution would be justified or practicable with alley distribution, which means when the cable pole is located at the entrance to the alley and a short pole line or spur is run through the alley for distribution. In places where a number of subscribers can be reached from one pole, such a pole is used as a distributing pole, and preferably a distributing fixture is used which consists of a number of metal brackets attached to two rings supported by four braces. Fig. 6 shows such a bracket with and without insulators. This one is made of ¼ x 1¼-inch Bessemer steel. The ends of the bar are slightly bent and act as wedges to spread the split pins when these are drawn up by screwing the insulators on. The use of a distributing ring with porcelain knobs, instead of insulators, is a cheap and objectionable method. In fact, knob insulators should be strictly kept out of all outside construction work.

With the tendency to use more cable, particularly aerial cable, and in some cases all cable, as where the streets are full of large trees and no alleys are available, the number of terminal boxes becomes very great; as there was need of much small cable, small terminals grew plentiful, particularly for 10 pairs, and the great call for terminal boxes brought new designs upon the market.

The iron cable box particularly marks an advance in the right direction. This cable box has a circular cast-iron base-plate upon which is securely fastened (or cast in one piece with the base) an iron frame holding one or more hard rubber plates provided with binding posts, 5 pairs or 10 pairs or 25 pairs to a plate. A cylindrical galvanized-iron cover sets over the frame and rests upon the circular base. Such a box may be fastened with its base on the top of the pole, or it may be provided with a cast-iron bracket by means of which the box may be fastened with lag screws to the side of the pole. The cable enters and leaves the box through a hole in the base. This kind of terminal box is also made with lightning arresters and fuses, as shown in Fig. 7.

Wooden terminal boxes are usually attached to the pole; very small boxes, however, may also be attached to two cross-arms. For small boxes, no special platform need be provided, as there will not be much for the linemen to do on such poles. But distributing poles should always be provided with some kind of a platform. Where much work is to be done, a regular seat may be provided of the kind illustrated in Fig. 8. Where more than one man is to work upon a pole, for testing or frequent jumpering, a balcony like the one in Fig. 9 would answer the purpose.

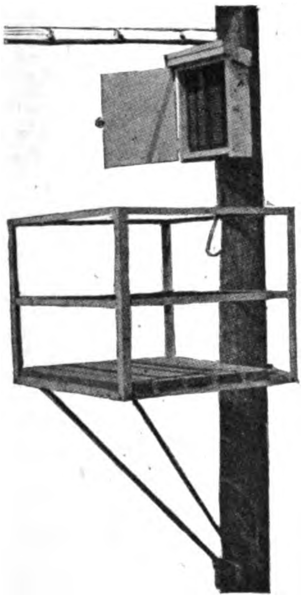

FIG. 9.

PREDETERMINING SOLENOID CHARACTERISTICS.

BY WM. A. DEL MAR.

The design of a solenoid for tractive work is a subject which is foreign to most text-books on electromagnetism. Why this should be so it is difficult to understand, as it is a simple matter to find a formula which will connect the three fundamental quantities which appear in the theory of solenoids. These three quantities are ampere-turns, flux and mechanical pull. The mechanical action of any solenoid or magnet depends on the fact that a magnetic circuit has a tendency to decrease its reluctance. Any iron or other highly permeable substance placed in a magnetic field will therefore tend to move towards where the field is strongest, as it is there that it is most effective in decreasing the reluctance. A piece of iron placed in a magnetic field so that no possible motion of the iron can decrease the reluctance of the magnetic circuit is not subject to any mechanical force due to the magnetism. The pull or force exerted by the field is thus dependent, not on the flux, but on the *flux gradient* of line differential of the flux.

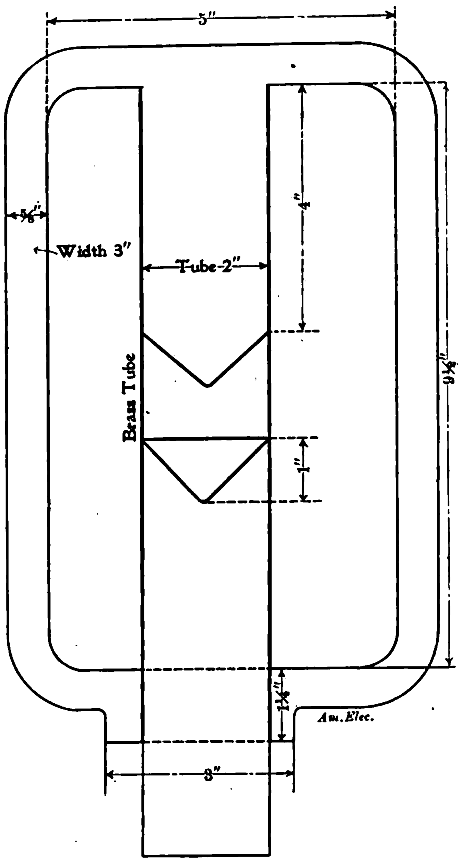

FIG. 1.—SECTIONAL ELEVATION OF SOLENOID.

When the core of a solenoid is moving so as to decrease the magnetic reluctance, the increasing flux gives rise to a back electromotive force in the windings. If

V = back electromotive force,
S = number of turns in the winding,
F = magnetic flux in maxwells,
t = seconds,
D = distance moved through (feet),

$$V = \frac{S}{10^8} \cdot \frac{dF}{dt},$$

watts expended usefully =

$$VI = \frac{IS}{10^8} \cdot \frac{dF}{dt},$$

$$\text{foot-lbs. per min.} = \frac{33{,}000}{746} \cdot \frac{IS}{10^8} \cdot \frac{dF}{dt}.$$

Now foot-lbs. per min. ÷ ft. per min. = lbs.; so that

$$\text{lbs.} = \frac{33{,}000}{746 \times 60} \times \frac{IS}{10^8} \times \frac{dF}{dt} \times \frac{dt}{dD}, \text{ or}$$

$$\text{lbs.} = \frac{738}{10^{11}} \times \textit{ampere-turns} \times \frac{dF}{dD}$$

where $\frac{dF}{dD}$ is the magnetic gradient in lines of force per linear foot.

If applicable to working conditions, this formula should be extremely useful in the design of solenoids, so that it is interesting to find how results obtained by the formula agree with experimental data. Three examples are given here in order to show that the gradient formula does give results which agree fairly well with practice.

Fig. 1 gives the sectional elevation of a solenoid which exerts a pull varying from 75 lbs. to 300 lbs. over a range of 1¼ inches. The actual curve of pull obtained by direct measurement is given in Fig. 2. There were 46,000 turns of No. 27 wire on this solenoid and the current taken was 0.234 ampere, so that the ampere turns amounted to about 10,800. Putting this in the "gradient" formula and inserting the necessary constants, curve 3 was obtained showing the gradient for different lengths of air-gap. The curve of flux may be derived from the gradient curve in the following way: Let G = flux gradient, F = flux increase,

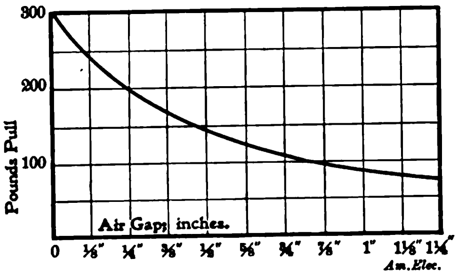

FIG. 2.—CURVE OF PULL.

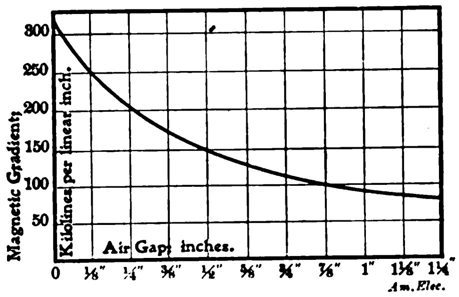

FIG. 3.—CURVE OF PULL.

and D = distance across the gap; then

$$G = -\frac{dF}{dD},$$

the sign being negative because as D increases, F decreases. Hence,

$$F = -\int_a^b G \,.\, dD + K$$

$$= K - \int_a^b G \,.\, dD$$

where $G.\ dD$ represents the change of flux between the limits a and b, and K, the constant of integration, is the flux when D is zero. In actual calculations the limits should be taken fairly close so that between them the curve does not depart very much from a straight line. In the case under consideration, if the limits be taken ⅛ inch apart the error will be very small, so that a sufficiently close approach to accurate integration may be effected by finding the areas of sections of the gradient curve for every ⅛ inch of air-gap. Thus in the section corresponding to an air-gap varying from 1⅛ in. to 1¼ in., the gradient is about 80,000 lines per linear inch. This average ordinate multiplied by the base gives the area of the section. Thus, 80,000 × ⅛ = 10,000 is the increase of flux, while the air-gap varies from 1¼ in. to 1⅛ in. This should be done for each of the ⅛-in. sections, so as to get the change of flux in each. The total flux for any position of the plunger is obtained by adding the proper increments to the original flux, or flux with no air-gap. This latter quantity must be found from the ampere-turns and the known dimensions of the magnetic circuit, and must be obtained by successive trials. In the case under consideration, a flux of 235,000 lines was found. The final trial is given below in order to illustrate the method.

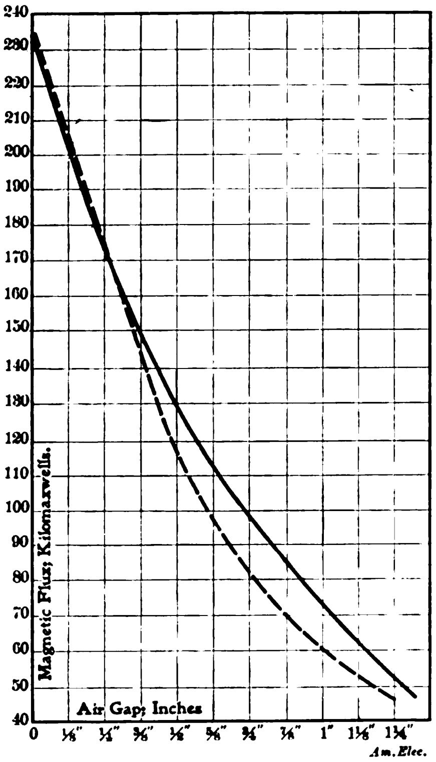

FIG. 4.

Wrought iron core:
Length = 24 cms.
Area = 12 sq. cms.
Assumed density, 19,600 lines; $\mu = 70$;
Total flux = 235,000 lines;

$$\text{Reluctance} = \frac{24}{12 \times 70} = 0.0288\ .$$

Wrought iron frame:
Area = 24 sq. cms.
Length along magnetic path, 40 cms.;

$$\text{Density} = \frac{235{,}000}{24} = 9800;\ \mu = 1200;$$

$$\text{Reluctance} = \frac{40}{24 \times 1200} = 0.0139\ .$$

Ring air-gap (the gap through which the plunger slides):
Height = 1¼ in.
Diameter = 2 in.
Area = $1\tfrac{1}{4} \times 2\pi \times 2.54^2 = 50$ sq. cms.
Length or thickness = 0.2 cm.

$$\text{Reluctance} = \frac{0.2}{50}\ 0.004\ .$$

Inside air-gap:
Owing to the existence of a stop the coned surface never approaches closer than 0.13 cm., so that the minimum reluctance is 0.011.

Summing the reluctances:

Core	0.0288
Frame	0.0139
Ring gap	0.0040
Inside gap	0.0110
Total	0.0577

$$\text{Flux} = \frac{4\pi}{10} \times \frac{\textit{ampere-turns}}{\textit{reluctance}}$$

$$= \frac{1.256 \times 10{,}800}{0.0577} = 235{,}000\ .$$

This agrees with the assumed flux and should therefore be correct.

A table can now be constructed on the following plan:

TABLE I.

Air-gap length. (Inches.)	Change of flux.	Flux.
Minimum	......	235,000
Min. to ⅛	34,400	200,600
⅛ to ¼	27,500	173,100
¼ to ⅜	22,800	150,300
⅜ to ½	19,400	130,900

The curve derived in this way is shown by the full line in Fig. 4. The dotted curve is not derived from the measured pull, but merely from the ampere-turns and reluctance, just as the flux of 235,000 lines was obtained above. The assumption was made that the ends of the core were flat instead of coned. It is interesting to note how closely the two curves shown in Fig. 4 agree, although where the air-gap is long the slope of the dotted curve is less than that of the full curve, while the opposite is the case where the air-gap is short. As the slope of the flux curve is really the magnetic gradient, it is seen that coning the ends of the core has a perceptible tendency toward equalizing the pull at different parts of the stroke. The curve shown in Fig. 5 is interesting as it gives the rise of current in the solenoid just considered.

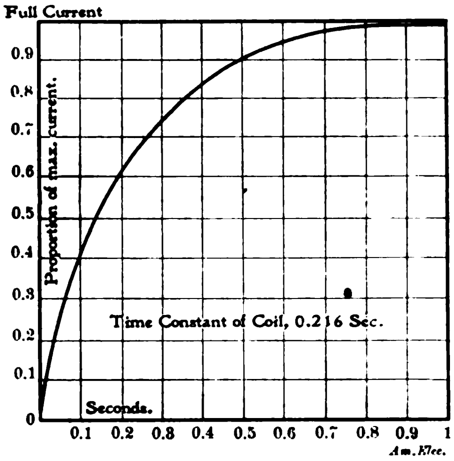

FIG. 5.

In the above example, a comparison was made of two curves of flux, one obtained directly by the law of the magnetic circuit, *i. e.*, from the ampere-turns and reluctance, and the other derived by means of the gradient formula from the measured mechanical pull. In the following examples, the flux will be calculated by the ordinary magnetic circuit formula, the gradient derived from that, and the pull calculated

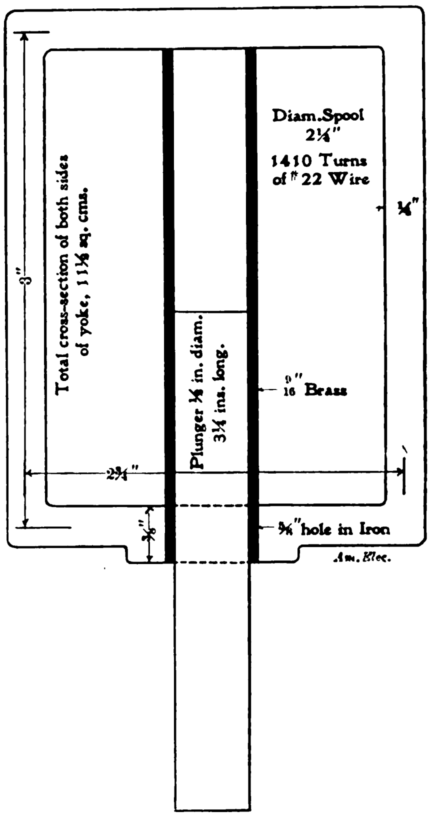
Diam. Spool 2¼"
1410 Turns of # 22 Wire
¼"
3"
Total cross-section of both sides of yoke, 11⅛ sq. cms.
Plunger ⅝ in. diam. 3¼ ins. long.
9/16" Brass
2¾"
⅜"
⅝" hole in Iron
Am. Elec.

FIG. 6.

from the gradient. This is the most important application of the theory here set forth. A comparison will then be made between the curve of pull derived from the formula and that obtained by actual mechanical measurement.

Fig. 6 gives the general dimensions of the next solenoid to be considered. As the air-gap varies between ¾ in. and 1¾ in., it is evident that the only reluctances that amount to anything are those of the air-gaps. The area of the ring air-gap, through which the plunger slides, is 4.72 cms. and its length about 0.159 cm. The reluctance is therefore $\frac{0.159}{4.72} = 0.034$, and this is the only one that need be added to the reluctance of the main air-gap. It is now possible to make up Table II., as shown, in which the headings explain themselves. The curve of pull plotted from this table is shown in Fig. 7 with the curve plotted from measurements.

It may be observed that the actual or observed pull is somewhat greater than that calculated, but they agree sufficiently well for most practical purposes. A perfect agreement between theory and fact cannot be expected because the quality of iron may not be exactly as assumed and because with small solenoids like this the observed pull may be greatly influenced by friction. As a matter of fact, the errors of observation in measuring the pull of the solenoid in question were so great that the curve could not be repeated so as to agree with the first observations any better than the theoretical curve does.

The next solenoid to be considered is intermediate in size between the two just discussed. Its general dimensions are shown in Fig. 8, but some are also given below. After trying four different flux densities in the wrought-iron core, a density of 17,200 lines per sq. cm. was found to fulfil the requirements as shown below:

Condition: Core all the way in, *i. e.*, with only a ⅛-in. air-gap.

Core:

Area = 9.65 sq. cms.

Density = 17,200 (assumed); $\mu = 172$.

Length = 17.78 cms.

$$\text{Reluctance} = \frac{17.78}{9.65 \times 172} = 0.01071.$$

Flux = 166,000 .

Cast-iron frame:

Area = 36 sq. cms.

$$\text{Density} = \frac{166{,}000}{36} = 4600;\ \mu = 383.$$

Length = 30.48.

$$\text{Reluctance} = \frac{30.48}{36 \times 383} = 0.00221\ .$$

Ring air-gap:

Area = 26 sq. cms.

Length = 0.318 cm.

$$\text{Reluctance} = \frac{0.318}{26} = 0.0122\ .$$

Inside air-gap (brass stop):

Area = 9.65 sq. cms.

Length = 0.318 cm.

$$\text{Reluctance} = \frac{0.318}{9.65} = 0.033\ .$$

The total reluctance is obtained by adding these:

Wrought-iron core	0.01071
Cast-iron frame	0.00221
Ring gap	0.01220
Brass stop, gap	0.03300
Total	0.05812

TABLE II.

Length of Air-gap.		Reluctance.					
Ins.	Cms.	Inside Gap.	Total or inside gap + 0.034.	Flux = (4π × Amp.-turns) ÷ (10 × total reluctance).	Flux change in ¼ in. (Differences from last column.)	Gradient in lines per linear foot (last column) × 48.	Pull in ounces. (By gradient formula).
½	1.25	.635	0.669	3,950			
¾	1.90	.950	0.984	2,680	1,270	61,000	15.1
1	2.54	1.270	1.304	2,020	660	31,700	8.0
1¼	3.17	1.580	1.614	1,630	390	18,700	4.6
1½	3.81	1.905	1.939	1,360	270	13,000	3.2
1¾	4.44	2.220	2.254	1,170	190	9,100	2.2

$$\text{Ampere-turns} = \frac{\textit{Flux} \times \textit{Reluctance}}{4\pi \div 10}$$

$$= \frac{166{,}000 \times 0.058}{1.256}$$

$$= 76{,}000 \text{ approximately.}$$

This is very near to 75,000, the number of ampere-turns actually on the solenoid, so that the assumption of a flux of 166,000 lines is about correct.

When the core is "out," the main air-gap is ½ inch, or 1.27 cms. long. The reluctance of the iron core and frame is then almost negligible.

$$\text{Reluctance of main air-gap} = \frac{1.27}{9.65} = 0.132$$

Reluctance of ring air-gap = as before =	0.012
Iron reluctances, about	0.004
Total	0.148

$$\text{Hence, flux} = \frac{1.256 \times 7550}{0.148} = 64{,}000\ .$$

Thus the change of flux in ⅜ inch = 166,000 — 64,000 = 102,000. This is equivalent to a change of 272,000 lines per inch, or about 3,264,000 lines per foot. Now, applying the gradient formula,

Pull lbs. =

$$\frac{738}{10^{11}} \times 7550 \times 3{,}264{,}000 = 181\ \textit{lbs.}$$

as the average over the ⅜ inch, which is what was found by direct measurement.

These three examples were the first with which the writer had occasion to test the gradient formula, but they afford good evidence that the formula is a useful one. There can be no doubt that if the data were worked out more carefully the discrepancy between theoretical and actual results would be less, not only because of the elimination of errors in applying the theory, but also of errors of observation in measuring the dimensions and the pull of the solenoid.

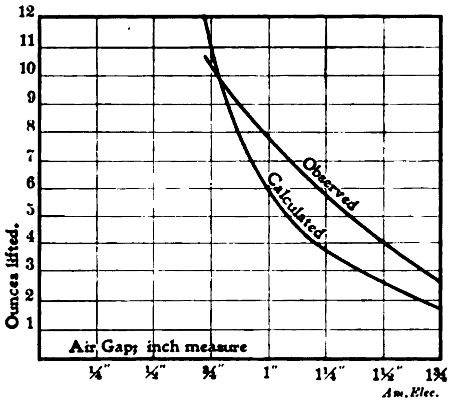

FIG. 7.

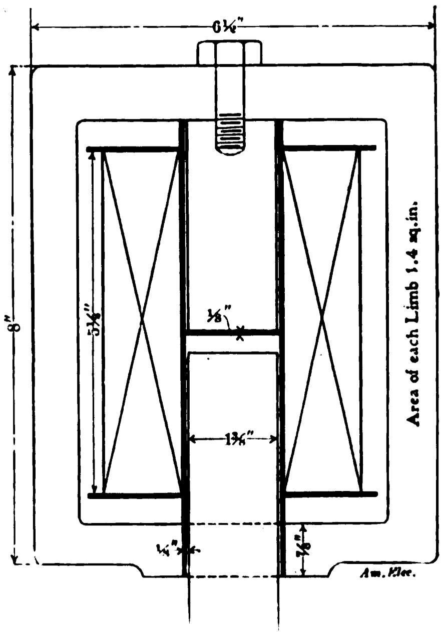

FIG. 8.

A modification of the gradient formula is useful in calculating the torque exerted by any solenoid or electromagnet with rotating parts. As before,

$$V = \frac{S}{10^8} \times \frac{dF}{dt},$$

where F is the flux, V the back electromotive force induced in the windings of the electromagnet or solenoid, and S the total number of turns of wire on the field and rotor, whether or not both have windings. The horse-power exerted at any moment

$$= \frac{VI}{746} = \frac{IS}{746 \times 10^8} \cdot \frac{dF}{dt}$$

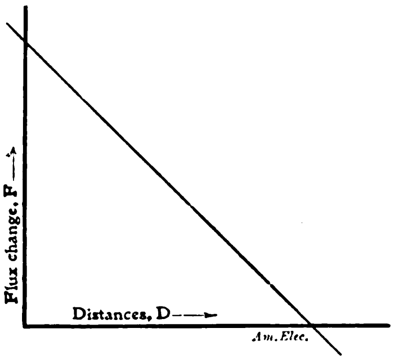

FIG. 9.

foot-lbs. per min. =

$$\frac{33{,}000}{746 \times 10^8} \cdot IS \cdot \frac{dF}{dt}.$$

Now, foot-lbs. per minute ÷ revolutions per minute = foot-lbs. per revolution, hence Foot-lbs. per rev. =

$$\frac{33{,}000}{746 \times 10^8} \cdot \frac{IS}{r.p.m.} \cdot \frac{dF}{dt}.$$

But radians per second, or $\frac{d\Theta}{dt}$, $= \frac{r.p.m.}{9.55}$

Foot-lbs. per rev. =

$$\frac{33{,}000 \times IS}{9.55 \times 746 \times 10^8} \cdot \frac{dF}{dt} \cdot \frac{dt}{d\Theta}$$

$$= \frac{33{,}000 \times IS}{9.55 \times 746 \times 10^8} \cdot \frac{dF}{d\Theta}.$$

Hence, Torque (lbs. at 1 foot radius) =

$$\frac{33{,}000}{9.55 \times 746 \times 10^8 \times 2\pi} \times IS \times \frac{dF}{d\Theta}$$

$$= 0.000{,}000{,}007{,}372 \times IS \times \frac{dF}{d\Theta},$$

where IS = ampere-turns and $\frac{dF}{d\Theta}$ = magnetic gradient in lines per radian.

This formula is especially applicable to such mechanisms as a commutatorless shuttle-wound motor or an equivalent device for obtaining rotation through a right angle.

It is interesting to consider some general deductions from the gradient formula:

$$\text{Pull in lbs.} = \frac{738}{10^{11}} \times IS \times G.$$

This may be written $P = kG$,

$$\text{where } k = \frac{738}{10^{11}} \times \textit{ampere-turns}.$$

As stated before,

$$F = -\int_a^b G \,.\, dD + K.$$

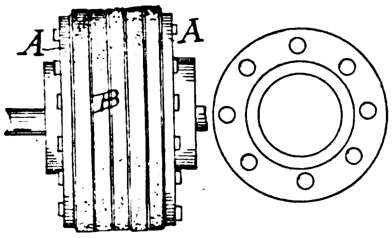

FIG. 1.—RAWHIDE WHEEL AND DISC—FIG. 2.

In order to get a uniform pull, it appears from the formula, $P = kG$, that G must be a constant. Hence,

$$\int_a^b G \,.\, dD = GD,$$

so that $F = -GD + K, = K - GD$ and the curve of flux is as shown in Fig. 9. This is very difficult to obtain in practice. A much more usual case is where the iron reluctances are negligible and the total reluctance is proportional to the air-gap length. In this case,

$$\text{Flux} = \frac{4\pi \times \textit{amp.-turns} \times \textit{area}}{10 \times \textit{length}}, \text{ or}$$

$$F = \frac{CA}{D},$$

$$\text{where } C = \frac{4\pi}{10} \times \textit{ampere-turns}.$$

Hence,

$$\frac{dF}{dD} = CA \frac{dD^{-1}}{dD}.$$

$$= -\frac{CA}{D^2}.$$

Thus the equation

$$G = -\frac{CA}{D^2}$$

represents the gradient curve when the iron reluctances are negligible. The actual gradient curves approximate to this form where the air-gap is considerable.

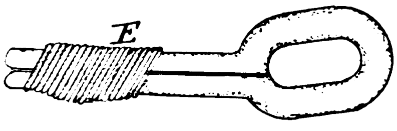

FIG. 4.—RAWHIDE BOUND TOOL.

SOME USES OF RAWHIDE IN THE FAR EAST.

(BY OUR MANILA CORRESPONDENT.)

I have been interested in observing the different applications of rawhide in connection with modern electrical apparatus and machinery, electrical wiring, etc. Rawhide is one of those commodities that one does not hear very much about in shop or mill, but it is a useful material to the electrical machinist, the wireman, the telegrapher, and others. The accompanying illustrations will give the reader an idea of some of the services to which the rawhide is put in the every-day electrical construction shop.

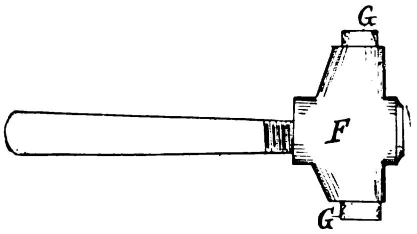

FIG. 5.—RAWHIDE FACED HAMMER.

I have noticed a number of wheels made for frictional contact purpose, designed on the pattern indicated in Fig. 1. The rawhide portion consists of the series of discs B, which may be almost any sizes from 2 to 12 inches in diameter. I have seen a number of little frictional wheels thus made for electrical machinery. The discs are clamped tightly between the flanges, A, which are secured to the shaft with proper set screws or keys. One of the discs in readiness for use is shown in Fig. 2. I have seen in some shops lagged wheels, in which a surfacing of rawhide, C, was applied to the rim, D, as shown in Fig. 3. The sheeting of rawhide is applied just as a leather lagging would be; it is fastened to the rim of the wheel by rivets.

The writer observed some odd-shaped tools in use, the handles of which appeared to be wound, as represented in Fig. 4 at E, with some material which close observation showed to be strands of rawhide. The binding enables the workman to grip the handle of the tool more securely. The strands are strong and reliable. Fig. 5 illustrates a type of rawhide-faced hammer employed in some of the electrical workshops. The erecting department is furnished with these hammers, for it is possible to deliver quite a telling blow upon painted metal with the rawhide-faced hammer and not damage the painting or finish. The hammer body, F, is

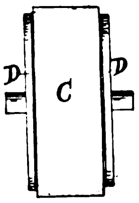

FIG. 3.

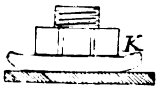

FIG. 7.

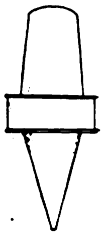

FIG. 8.

frequently made of a pipe tee, in each end of which is set a plug of rawhide, *G*. The handle may be a section of pipe threaded into the tee as shown. These hammers are usually made to order by the local machinists.

I have also noticed that rawhide stock is being utilized in connection with journals of electrical apparatus. The surface of sheet rawhide, when properly fitted as a sleeve or lining for a bearing, makes a yielding bed for the revolving shaft. It is not considered workman-like to use rawhide extensively for this purpose, but worn bearings, bearings made undersize, and refractory bearings have been refitted with rawhide linings and made to run indefinitely.

I saw a journal bushed with a rawhide sleeve about ⅛ inch thick. On the other hand, I noticed some electrical machinery in which the workman had used a rawhide sleeve (Fig. 6) bushed with a split metal liner. The object of this odd arrangement was to get an elastic support for the journal sleeve. The tough yet flexible rawhide eased the shaft just enough to give the special conditions sought by the machinist.

I found that rawhide washers on electrical devices were a failure except when thin metal washers were used on the upper side of the rawhide. Fig. 7 indicates what occurs when rawhide washers are used without the proper protecting washers of metal. The rawhide washer is represented at *K*. Shrinkage and various conditions of wear, tear and exposure, would tend to impair the solidity and uniformity of the rawhide washer on any machine, unless there were a proper capping washer of metal at least as large in diameter as the rawhide washer itself.

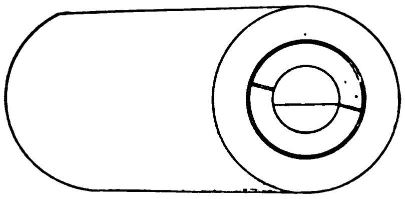

FIG. 6.—RAWHIDE SLEEVE BUSHED WITH SPLIT METAL LINER.

I have seen rawhide pins in use in the wood-working department of some electrical wood frame construction shops. The pins are about an inch in diameter and are calculated to take the place of wood pins in securing parts of wood frames; the pins are tapered and serve their purpose quite well.

Fig. 8 shows a form of stud made of rawhide. The pointed part is sunk into a hole and screws through the flange or shoulder to secure the pin in position. The slightly tapered projecting stud can be used for several purposes. Link chains of rawhide are made by riveting several ticknesses of the appropriately cut rawhide together. Each link is looped with its corresponding link, of course, before the rivets are put in. After the parts are riveted, the rivets are smoothed down with a file and the chain finished off.

Abstracts from Foreign Contemporaries

Small Gas Engines vs. Electric Motors. Gas engines operated under favorable conditions are certainly economical as a source of power, and it is often very difficult to persuade users to abandon them in favor of an electric motor. The power represented by such engines would constitute a very desirable load for any central station capable of supplying it, since the average result would be a fairly steady load which would be worth a considerable amount of trouble to get. A writer in a recent issue of the London *Electrical Review*, who is endeavoring to replace a large number of small gas engines by electric motors, has carefully inquired into a considerable number of cases with some remarkable results. He cites this typical example: A 14-brake-horse-power gas engine in a joiner's shop, stated to work at an average of half-load for 48 hours a week, which is equivalent to 7 brake-horsepower for 624 hours per quarter. The actual gas bill for the quarter was $26.70. A brief calculation shows that for the load and hours stated current at $0.03 per unit would cost $121.50. Illuminating gas is used at $0.60 per 1000. Taking the consumption of gas at an average of half-load as 30 cu. ft. per brake-horse-power-hour, for the load and hours given the gas bill should amount to $79.44. It is therefore evident that the engine does not do one-third of the work with which it is credited. The brake-horse-power-hours equivalent to a gas bill of $26.70 are 1467 instead of 4368 as stated, so that the actual performance of the engine may be stated as a first approximation as 7 brake-horse-power for 209 hours per quarter. The engine is however running for 624 hours per quarter, so it must be running for 415 hours per quarter without load. Such an engine would consume 50 cu. ft. of gas per hour when running empty which would amount to 20.75 thousand cu. ft. per quarter or $12.60 out of a total bill of $26.70. But this amount of gas has done no useful work and the equivalent must therefore be deducted from the brake-horse-power-hours above arrived at. $27.60 per quarter is equal to 44,000 cu. ft. less 20,750 cu. ft. or 23,250 cu. ft.; which is equivalent to only 775 brake-horse-power-hours of useful work per quarter. The total cost of running the gas engine per quatter including wages, repairs, etc. is $43.74 or $.057 per brake-horse-power-hour of useful work. Taking the case of electricity, in this case to be supplied at say $.03 per unit to a polyphase induction motor with 82 per cent efficiency, and assuming that care is exercised in switching off the motor when not required, he finds that the total cost of running the motor per quarter is $24.42 or $.031 per brake-horse-power-hour. The saving due to electric power is therefore $78.24 per annum or 44½ per cent. Interest, depreciation, etc., are neglected in both cases, as it is a question of exchange and not of first choice, and, therefore, does not appeal much to the consumer. The inclusion of these items would, of coures, make the comparison still more favorable to the motor. It may be noted also that 30 cb. ft. of gas per brake-horse-power-hour, with gas at $0.60 per 1000, works out to $0.18 per brake-horse-power-hour, which does not at first sight look like an easy figure to beat. The above calculation might be worked out in many different ways, but to assume that the engine really does average half-power, as stated by the owner, appears as fair a basis as any. It is probable that in practice the comparison will, in many cases, be even more favorable than the above. Gas engines have usually small overload capacity, so that an engine of rated power, at least equal to the maximum load expected, must be installed. Thus in the above case the 14-brake-horse-power engine works at an average of half load (probably much less), and the efficiency would not be above 76 per cent. On the other hand, standard polyphase induction motors can be obtained with a guaranteed overload capacity of 50 per cent for one hour, or 25 per cent for 10 hours, and for intermittent work in such a case as that given a 10-h.p motor might be safely installed to deal with the load. Such a motor would then operate at an average of about three-quarter load, with an efficiency of at least 82 per cent, and at lighter loads the advantage would be still more marked.

Notes on Dielectric Losses.—Dr. Paul Holitscher, in a recent contribution to the *Elektrotechnische Zeitschrift*, communicates the results of measurements on dieletric hysteresis in the micanite tubes used for insulating the conductors in high-voltage machines. The dielectric losses between the magnet frame (which was earthed) and the armature copper of a 10,000-volt 500-h.p., three-phase synchronous motor were first determined. At a constant frequency of 53.3 cycles per second the losses given in Table I. were observed, and it will be seen that the increase is—for the higher pressures—approximately proportional to the third power of the voltage. The capacities derived from the measurements with the aid of the transformer diagram, are also given in the table, and it will be seen that they increase with the pressure:

TABLE I.

Secondary of Testing Transformer. Volts.	Amps.	Dielectric losses. Watts.	Capacity. Mfd.
9,000	0.115	354	0.0365
13,150	0.174	785	0.04233
15,130	0.213	1,265	0.0458
18,000	0.293	2,290	0.0538
20,050	0.365	3,470	0.0616
21,550	0.43	4,860	0.0700

When the machine is in service, the neutral point of the phases is connected to the frame, and only the extreme end of each winding has, therefore, the maximum potential of 5,770 volts. If, from about 6,000 volts downwards, the dielectric losses are assumed to be proportional to the square of the pressure, the lost energy through dielectric hysteresis will amount in the above case to 40 watts—*i.e.*, 0.013 per cent. of the full load output. Some results obtained with a second machine, designed for 400 kilowatts at 10,000 volts, are tabulated below (Tables II. and III.):

TABLE II.

Frequency per sec.	Secondary of Testing Transformer.		Dielectric losses.	Capacity.
	Volts.	Amps.	Watts.	Mfd.
40	15,500	0.101	572	0.0282
45	15,500	0.114	648	0.0281
50	15,500	0.127	726	0.0280
55	15,500	0.135	767	0.0272
60	15,500	0.147	820	0.0270
65	15,500	0.155	880	0.0265

TABLE III. (50 Cycles per Sec.)

Impressed volts.	Dielectric losses. Watts.	Capacity. Mfd.
12,000	290	0.0213
15,500	726	0.0280
19,200	1,145	0.0332

To complete the tests, the insulation resistance of the second machine was measured and found to be 21 megohms. At a voltage of 15,500 volts, therefore, the I^2R losses ($R=21$ megohms) would be about 12 watts, which does not materially affect the result of the tests.

Gutta Gentzsch.—This is the name of a new insulating substance recently introduced into England, and which, if accounts be true, has already achieved a remarkable measure of success on the Continent. Judging from the account published in a recent issue of the London *Electrical Review* "Gutta Gentzsch" should in the near future play an important part in the insulation of submarine cables particularly as the growing scarcity of gutta-percha and the consequent enhancement of its price have rendered the use of unadulterated gutta-percha almost prohibitive. Various mixtures are employed, none of which are however given, according to whether it is designed as a substitute for gutta-percha in the insulation of submarine cable cores, or whether as an insulator for electric light wires and cables for use on land. The material has been used for some time in Germany so that it is not by any means a mushroom growth. A few of the physical and electrical properties of this material are of interest. The dielectric resistance is equal to that of natural gutta of similar quality. The softening point is considerably higher than that of natural gutta-percha ("Gutta Gentzsch," about 130°; real gutta, about 100°). In the case of submarine cores the capacity rises for some weeks after immersion, but attains a constant value which compares well with the inductive capacity of similar sized real gutta-percha cables. The price is very much lower than that of real gutta-percha. The specific gravity is about the same as that of water. "Gutta Gentzsch" cools more rapidly than real gutta-percha, this being an important advantage from a practical standpoint in the covering of wires with the material. The resistance of "Gutta Gentzsch" to the influence of oxidation and of the effect of light is remarkably great, as compared with natural gutta, which, as is well known, soon becomes hard and brittle, and entirely loses its valuable properties when exposed to light and air, particularly in dry positions. With regard to this latter property, two experiments may be mentioned: Dr. Weber exposed thin sheets of "Gutta Gentzsch" and of natural gutta-percha to the action of oxygen at a temperature of 86° Fahr. for eight days and nights at the end of which time the gutta-percha had become so oxidized as to fall to pieces on handling, whereas the "Gutta Gentzsch" was very little oxidized and was practically unchanged as regards suppleness. A corroboration of this is found in the behavior of a coil of wire covered with "Gutta Gentzsch" and exposed to the atmosphere and sun for two years. This could be twisted until the copper conductor broke without breaking the "Gutta Gentzsch" covering. Mr. James Swinburne also attests to this peculiar characteristic of the material. The field for "Gutta Gentzsch" is not limited to its being used as a substitute for natural gutta-percha, as its name would seem to imply. It has already been determined that it can be employed successfully, both electrically and commercially, as an insulating medium for electric light wires and cables, which are now insulated with vulcanized india-rubber, and the reason is not far to seek. It is well known that vulcanized india-rubber cables do not stand well in damp places, whereas damp does not appear to effect "Gutta Gentzsch" at all. In this regard it behaves more like the natural gutta-percha. Further, the specific gravity of the rubber mixtures which are used for the good quality of insulated wires and cables, ranges from the minimum of 1.5 to 1.7 and even higher; whereas the specific gravity of "Gutta Gentzsch" is very little higher than that of water. "Gutta Gentzsch" floats when it is warm and gradually sinks when cold, the specific gravity being about 1.03, but varying slightly with the various qualities. These two circumstances, taken in conjunction with the comparative hardness of the material as compared with gutta-percha, and its high dielectric resistance, should render it eminently suitable for the insulation of wires and cables and for a wide variety of other purposes.

Water-Tube vs. Flue Boilers.—At a recent meeting of the Manchester Association of Engineers, Mr. A. Hobbs read a paper on water-tube boilers for stationary work. Mr. Hobbs, in his paper, after describing in detail the respective types of tube boilers now principally in use, said that the Lancashire boiler was still the most popular steam generator for mill and factory purposes, and, properly worked, it was certainly an efficient tool, but probably its most ardent admirers would admit that it was not perfect as a steam generator. He thought they would agree that the heat efficiency of a boiler and the rapidity of its water circulation were almost inseparable. The circulation in a Lancashire boiler was due to convection currents alone. In a water-tube boiler the circulation was due not only to convection, but to the actual difference in density of two columns of water of different temperature separated from each other. Other factors, all tending to give the water-tube boiler a higher heat efficiency than the Lancashire boiler, were the splitting up of the gases into smaller streams, the thin envelope separating the hot gases from the water, in comparison with the thickness of flue plating in a Lancashire; and the fact that the external surfaces of the water-tube boiler could be cleaned or scraped, through the access doors in the sides of the setting whilst the boiler was under steam, whereas access to the external flues of a Lancashire boiler could only be obtained during a stoppage, usually at rare intervals. It was a significant fact that water-tube boilers were now being largely used in collieries, ironworks, and other places, where, only a few years ago, they were seldom heard of. The most important questions from a steam user's point of view were, whether by using water-tube boilers he could reduce his coal consumption, running and maintenance costs, and obtain increased reliability for approximately the same outlay as would be incurred by installing shell or fire-tube boilers? The cost of the water-tube boiler installation could be taken at 3 per cent lower than for the Lancashire boiler installation, and, at the same time, it occupied 30 per cent less floor space. As regarded efficiency or coal consumption, makers of any of the leading types of water-tube boilers would guarantee an efficiency of not less than 70 per cent of the heating value of the fuel, under ordinary conditions, say, 10 lb. of water per pound of coal, and if they took what was a high figue, *i.e.*, 9 lb. for the Lancashire boiler, the reduction in coal consumption was still 10 per cent in favor of the water-tube boiler. Mr. S. Boswell contended that if a large surface for liberation of steam bubbles was of importance, the Lancashire or shell boiler had a very great advantage over any other type. He did not think so much need be made out of the scale and deposit question. Only a few days ago he had taken out a flue boiler after thirty years' work night and day, and during the whole of that time a tool had never been used on it by way of repair. So far as economy was concerned, he might give two trials in America of water-tube *vs.* flue boilers, the results of which were: Galloway, 12.012 lb., water per pound of combustible; Babcock, 11.88 lb., of water per pound of combustible; water in steam, Galloway, 0.57 per cent; water in steam, Babock, 3.24 per cent. Mr. Piggott said it had been claimed that in some of the best tube-type of boilers it was almost impossible for these to become scaled. All he could say was that no amount of rapid circulation of water etc., would stop scaling, and that where water contained scale-forming properties the latter would be deposited. He had seen scale under all conditions and in almost every type of boiler, and no theory would convince him that scaling was an impossibility in a water-tube boiler. He agreed that the Lancashire type of boiler was not good for high-pressure steam. The boiler had to be held together by what he called "brute force," the strains on the structure being enormous. There was too much made of the capacity of the Lancashire boiler. The water-tube boiler could do just as well with sudden demands of steam as the Lancashire boiler and the American used, comparatively speaking, nothing else but the water-tube boiler. There was, however, one certain thing with a Lancashire boiler, unless it had its economizer behind it, it was a very uneconomical type of steam-raiser.

Governing Engines Driving Electric Generators.— When the load on an engine driving a dynamo varies suddenly, the governor must be moved quickly in order to alter the rate of admission of the working medium to the proper amount. This quick movement, however, involves a corresponding expenditure of energy which is not obtained from the governor until considerable variations have taken place in the number of revolutions of the engine. It follows therefrom that the governing of the engine lags behind variations of load, and the fluctuations of the potential of the dynamo, driven by the engine, are not compensated for, and the increase of speed of the engine altered, until a corresponding current impulse has passed. The London *Mechanical Engineer* describes an invention of the German firm of W. Lahmeyer & Co., the object of which is to provide in connection with the governors of engines employed for driving electric generators an electrical device for accelerating or retarding the governor in its controlling action. The centrifugal governor of the driving engine is controlled in its action by a solenoid traversed by the working current, the core of the solenoid acting either directly or indirectly on the sliding sleeve of the governor, the controlling of the governor magnet being effected, without the intervention of any intermediate members, by the main current of the dynamo. Any variation of the load on the dynamo affects the working of the engine governor before the speed of the engine has undergone any important variation. The equalization of the load and energy supply are thereby effected earlier and the fluctuations decreased both as regards time and magnitude. Fig. 1 is a diagrammatic view of the device proposed. *R* is the centrifugal governor, the sleeve *M* of which can be shifted by the force exerted by the core *K* of the solenoid *S*, which is included in the circuit of the dynamo *D*, so that the magnetic pull acting on the core *K* varies according to the load on the line *N*. A sudden rise of the current that flows through the solenoid *S* will therefore assist the governor in its action.

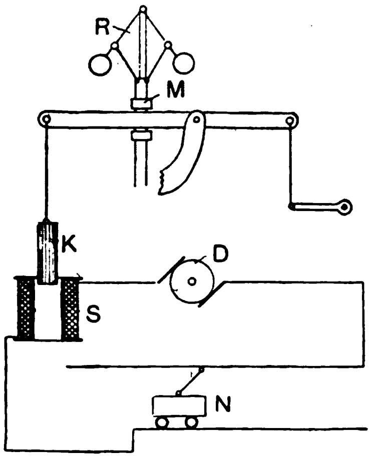

FIG. 1.—ENGINE GOVERNOR.

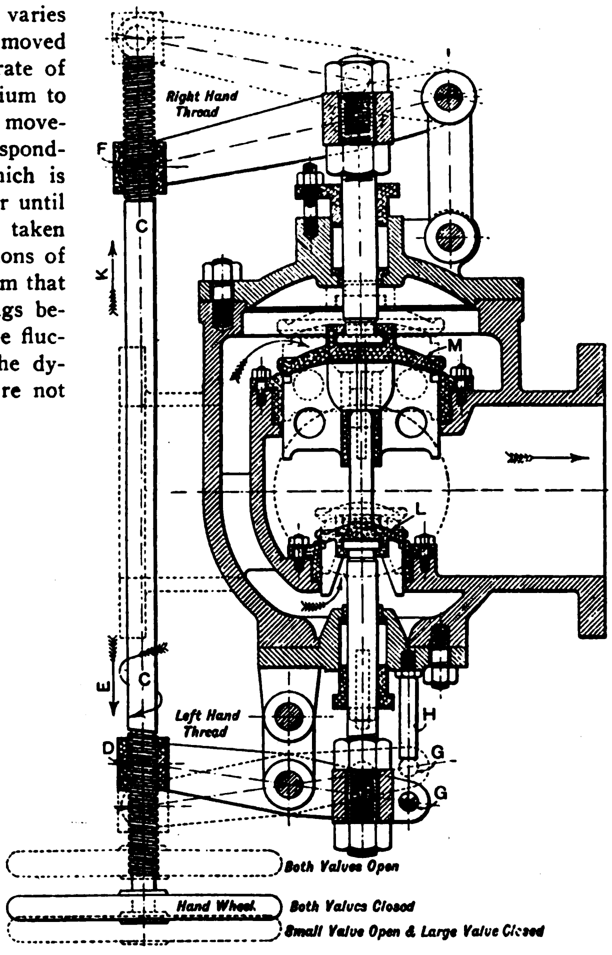

FIG. 2.—BALANCED STOP VALVE.

A New Balanced Stop Valve.—In order to overcome the difficulty of leakage and want of easy control experienced with single-seat and double-beat valves of the ordinary type, Holden & Brooke of Manchester, England, have introducted a new balanced stop-valve, the design of which will be clearly understood by reference to Fig. 2. The two valves are to a certain extent independent in their movement on one another. The smaller valve *L* has the pressure on its under side, the admission steam pressing on the larger valve *M* from above. It is evident that, when opening the valve, the small valve *L* will be the first to open and will continue to do so until the pin *G* comes into contact with the stop *H*. By this time the pressure has become equal on both sides of the larger valve, and, if the turning of the handwheel be continued, the large valve will now be lifted. The spindle *C* has a left and a right-hand thread. Although each valve is closed positively and independently, no force is required to open them, since the opening movement is assisted by the steam pressure on the under side of the small valve. It is said that the time required to open or close the valve is very short, only 12 turns of the handwheel being required, for example, to fully open or shut the 10 in. size of valve. In the standard pattern, the valves and seatings are made of phosphor bronze, the bodies being of cast-iron, steel or gunmetal according to steam pressure. The valve can also be made to operate by direct lever action instead of by screw. We are indebted to the London *Electrician* for the foregoing illustration and data.

Losses in Porcelain Insulators.—In an article on this subject by R. M. Triese in the *Elektrotechnische Zeitschrift*, it is stated that porcelain insulators may be regarded as small capacities, the two sides of which are formed by the holder (earth) and the wires respectively, the dielectric being the porcelain. In certain tests, a large number of insulators connected in parallel were suspended head downwards in a bath of water connected to one terminal of the testing transformer, the surface of the water being level with the neck of the insulator. The

TABLE I.

Impressed voltage.	Amps. taken by insulator.	Power-current Amps.	Wattless-current Amps.	Watts lost.	Apparent loss Volt-amps.	Power-factor.	Capacity. Mfd.
5,000	0.0000474	0.0000059	0.0000465	0.0295	0.237	0.124	0.0000296
10,000	0.0000948	0.0000131	0.0000930	0.131	0.948	0.138	
15,000	0.0001422	0.0000214	0.0001395	0.321	2.13	0.151	
20,000	0.0001896	0.0000303	0.000186	0.606	3.79	0.160	
25,000	0.000237	0.0000401	0.0002325	1.002	5.925	0.169	
30,000	0.000284	0.0000510	0.000279	1.530	8.53	0.180	
35,000	0.000332	0.0000625	0.0003255	2.190	11.61	0.188	
40,000	0.000379	0.0000747	0.000372	2.990	15.17	0.197	
45,000	0.000427	0.0000870	0.0004185	3.915	19.20	0.204	
50,000	0.000474	0.0000995	0.000465	4.975	23.70	0.210	

TABLE II.

Impressed voltage.	Amps. taken by insulator.	Power-current Amps.	Wattless-current Amps.	Watts lost.	Apparent loss Volt-amps.	Power-factor.	Capacity. Mfd.
5,000	0.0000418	0.0000049	0.0000415	0.025	0.209	0.1172	0.0000264
10,000	0.0000836	0.0000098	0.0000830	0.098	0.836		
15,000	0.0001254	0.0000147	0.0001245	0.220	1.881		
20,000	0.0001672	0.0000196	0.0001660	0.392	3.344		
25,000	0.0002089	0.0000245	0.0002075	0.612	5.225		
30,000	0.0002508	0.0000294	0.0002490	0.882	7.524		
35,000	0.0002926	0.0000343	0.0002905	1.200	10.24		
40,000	0.0003344	0.0000392	0.0003320	1.568	13.38		
45,000	0.0003762	0.0000441	0.0003735	1.985	16.93		
50,000	0.0004179	0.0000490	0.000415	2.450	20.89		

holes in the insulator, provided for the iron supports were filled with water, and electrical contact with the other pole of the transformer was made by means of metallic chains dropping in the holes. In Tables I and II are recorded the results of the tests. Table I refers to an insulator of an older type, possessing a double petticoat and weighing 3.44 lbs., while Table II concerns a modern type of insulator with four petticoats and weighing 2 lbs. Both types withstood approximately the same disruptive tension. The frequency of the testing current was 50 cycles per second.

SOME RECENT ELECTRICAL PATENTS

Lamp Receptacle for Conduit Mounting.—Figs. 1 and 2 illustrate a compact lamp receptacle intended to be mounted directly on the side of a conduit pipe, as shown clearly by Fig. 2; the pipe to have a rectangular hole cut in the side, as indicated at *a*, Fig. 1, to receive the downward projection of the receptacle base. This projection, b_2, carries the connecting lugs, b_3, and b_4, of the socket, and the wires in the conduit are clamped to the lugs without being cut. In applying the receptacle to a piece of conduit pipe, the wires are pulled through the hole *a* in bights, the insulation cleaned off for a suitable distance, and the conductors clamped under the binding screws of the socket; then the wires are drawn taut in the conduit and the receptacle base set into the hole. The receptacle base is screwed to the wall of the conduit pipe, and the shell *C*, which entirely encloses the base as well as the lamp socket, is held in place by the springs *c* and *c*, Fig. 1. Patent No. 752,834.

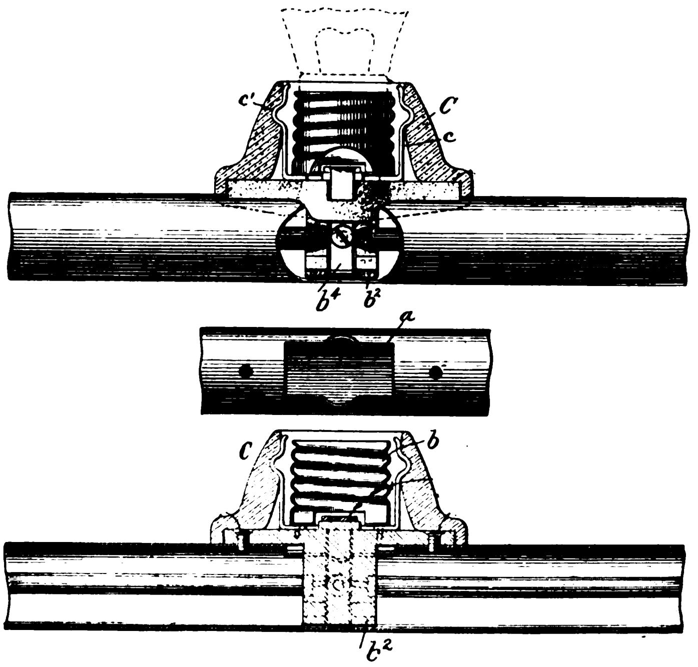

FIG. 1.—LAMP RECEPTACLE FOR CONDUIT MOUNTING.

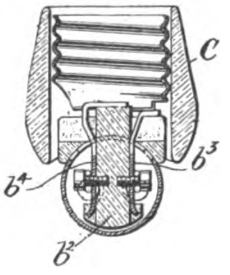

FIG. 2.

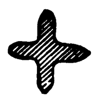

FIG. 3.

Insulator Pin.—With the view of producing a pin for supporting the large, heavy porcelain insulators now used for high tension transmission lines without involving the location on the cross-arms of an undue weight of material, James H. Bullard, of Springfield, Mass., has devised the form of pin shown by Figs. 3 and 4. The pin is to be made of cast metal, presumably steel, and the upper portion of it is of the cross-shaped cross-section shown by Fig. 3, which is taken on the line *2—2*. The four vertical webs separate toward the bottom end of the pin, and their lower ends are united in a disc or plate, *c*, from the under side of which projects a hollow shank, *d*. Making this shank hollow confers two advantages: the pin is lightened and there is space for the retaining bolt, *P*, without having to drill through the shank. The bolt passes through the base plate, *c*, and is provided with the usual nut and washer at the lower end. The upper part of the pin is notched, as shown at *g*, but not necessarily in the form of a screw thread; it is contemplated to serrate the interior of the insulator at *i*, and to pour cement or molten metal into the insulator while the pin is in it, this cement or metal being intended to fill in the spaces between the webs and take hold of them and the insulator by filling also the serrations and notches. The inner "petticoat" of the insulator is indicated, of course, by the dotted figure, *h*. Patent No. 754,123.

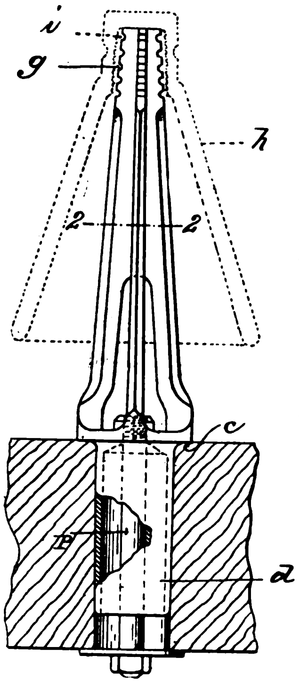

FIG. 4.—INSULATOR PIN.

◆◆◆

Machine Tool Motors.

To the Editor American Electrician:

I have read with interest an editorial which appeared under the above heading in your March issue, and which I consider a timely warning against the indiscriminate use of any given system of motor speed control.

In the first paragraph, I noticed the sentence, "It is not often, however, that individual motor drive is economical in very small units; it is also frequently inadvisable to obtain variable speed by means of complex systems of supply." Doubtless no one could be found to question the truth of these statements; and if any criticism were made, it would be on the ground that the reader is left with the impression that variable speed is to be secured only at the sacrifice of efficiency or by use of complex systems.

In the third division of the editorial referred to, a comparison is drawn between the multiple voltage and double commutator method of speed control. Here again I should be inclined to criticise this paragraph, not on account of any statement contained therein, but on account of what was left unsaid. I think that the uninformed reader would naturally arrive at the conclusion that there were just two methods of variable speed control, the multiple voltage and the double commutator method; and that if he doesn't like either one, there is no alternative. The fact is that those who have had occasion to investigate the various methods of speed control are aware of the fact that there is upon the market at least one type of variable speed motor in which, without sacrificing other desirable features, the limit of simplicity appears to have been reached. I refer to the motors known to the trade as Stow multi-speed motors, built by the Stow Manufacturing Company, Binghamton, N. Y.

As in nearly all other motors, the pole-pieces of the Stow machine are stationary, the speed variation being accomplished by the simultaneous adjustment of cylindrical iron cores within the pole-pieces; this arrangement permits a wide variation in field strength without detriment to commutation. These motors furnish their full rated output at the lowest speed or at the highest, or at any desired speed between these limits and with a high and practically uniform efficiency over their entire range. In moderate sizes, these motors have a range of speed in ratio of 1 to 2.25 when operated on a two-wire circuit, 1 to 4.5 on a three-wire system, or 1 to 9 when furnished with double commutator and fed from a three-wire system.

It would appear that a motor having these characteristics is entitled to mention in an article purporting to compare the available methods of speed control. If the general use of this motor is questioned it may be mentioned that hundreds of them are in actual use in this country and in Europe, and that the makers will gladly refer to plants in which scores of these motors are in operation.

If the editorial referred to was written with a desire to inform, which I do not question in the least, it seems hardly consistent for comment to be directed against this and that complex method without calling attention to improvements in the art by which complexity is avoided.

G. F. PACKARD.

Binghamton, N. Y.

[We are glad to give publicity to the foregoing views. We may say, however, that our remarks were entirely general and not intended as a criticism of multiple speed *per se*, nor as a discussion of the merits or demerits of any particular system; the aim was merely to indicate in a broad way conditions under which a few well-known classes of speed control would probably make the best showing. As intimated in these remarks, it would not be practicable, within the limited space of our editorial pages, even to refer to, much less to discuss adequately, all of the specific methods of obtaining a multiplicity of motor speeds.—EDITOR.]

◆◆◆

NOTES.

Iowa Electrical Association will hold its convention this year at Des Moines, Ia., April 13 and 14.

A Correction.—In the annual fan motor article which appeared in our last issue, it was stated on page 130 (31st line of the first column) that the Eck oscillating fan motor is tilted forward and back by the oscillating mechanism. This statement was erroneous; the oscillating mechanism causes the motor to swing from side to side like the others of its class.

James Watt Memorial.—A memorial statue is to be erected in Greenock, Scotland, on the site of the cottage in which James Watt was born. For the purpose of obtaining American subscriptions to this memorial, an American committee, of which Mr. Andrew Carnegie is chairman, has been appointed. The committee consists of the presidents of the Electrical, Mechanical, Mining and Civil Engineers' national organizations, together with men prominent in the industrial world. Contributions to the memorial fund should be sent to Mr. Theodore Dwight, secretary and treasurer of the American committee, whose headquarters are at 99 John Street, New York.

A Flourishing Municipal Lighting Plant.—The eleventh annual report of the Board of Electrical Commissioners of South Norwalk, Conn., for 1903 makes a very favorable showing for the municipal plant of that city. It is obvious from the financial results, the personnel of those directly responsible for these results, and the municipal policy which determines this personnel, that the success of the plant is due primarily to the absence of politics in its control. The system is in the immediate charge of Mr. Albert E. Winchester, who is allowed to operate it on a purely business and engineering basis, and he deserves hearty congratulations upon the results of his efforts.

Safety Precautions for the Berlin Underground Railway.—Shortly after the Paris disaster, a commission was appointed to determine such precautionary measures as would be likely to increase the safety of service on the Berlin underground railway. The recommended precautions have now for the greater part been carried out. To the lighting circuits of the tunnel has been added an extra independent wire, so that in the case of one-half of the circuits being injured, the second half will not be affected. The conductors' stands on the underground railway stations are so designed as to be readily pushed aside. The number of fire hydrants has been increased, and each car has been fitted with a sand box. There are bucket fire engines in each car, as well as in the tunnel at distances apart of 100 meters (328 feet). Each station has been connected to the fire brigade alarm line. The emergency lamps in the cars are prevented from coming into contact with the curtains, and the latter are of a heavy impregnated wool stuff. Each motorman's stand is provided with devices which may be operated, even within the car, serving to cut the current off the line.

The Allis-Chalmers—Bullock Amalgamation.—One of the most important industrial deals that has been consummated since the formation of the General Electrical Company was put through recently by the practical amalgamation of the Allis-Chalmers and the Bullock Electric Manufacturing Companies. The contract made by these companies provides for the organization of a new Bullock Company with a paid-up capital of $500,000, all common stock, to lease the plant of the present Bullock Electric Manufacturing Company, which company will remain intact. The lease will be for a term of twenty-five years, with the privilege of renewal. Mr. George Bullock, president, and Mr. Joseph Neave, vice-president, of the present Bullock Company will be president and vice-president of the new company, and these two gentlemen together with three officers of the Allis-Chalmers Company will form the board of directors of the new Bullock Company. The plants of the Allis-Chalmers and Bullock Electric Manufacturing Companies will be, of course, operated as though they were absolutely owned by a single organization. The combination is a strong one. As is well known, the Allis-Chalmers Company is prepared to build, in addition to its well-known steam engines, the Nurnberg gas engine and has also arranged with an English syndicate for the manufacture of horizontal turbines. Arrangements have been made also with the Swiss firm of Escher, Wyss & Company for the manufacture of the water turbines and other hydraulic machinery controlled by the patents of that company. The Bullock Company has facilities for manufacturing complete lines of electrical apparatus for every class of lighting and power service. This company built for the Cincinnati Gas & Electric Company the largest direct-connected 60-cycle alternator that has ever been manufactured, and is also said to have built the largest synchronous motor sets in the world, which are in operation in Canada. The alliance with the Allis-Chalmers Company will result in very large additions to the manufacturing facilities of the Bullock plant.

Union Engineering Building.—It is well known to our readers that Mr. Andrew Carnegie offered to furnish the money to erect a union building for the Electrical, Mechanical, Mining and Civil Engineers' national organizations and the Engineers' Club of New York, and the prospect appeared favorable for the consummation of this plan until the American Society of Civil Engineers, on March 2, voted against the acceptance of Mr. Carnegie's offer, the vote standing 1139 to 662. This action, of course, cancelled the original offer, but Mr. Carnegie immediately renewed his offer to the other organizations in the following letter:—

ANDREW CARNEGIE,
2 East 91st Street, New York.
March 14th, 1904.

GENTLEMEN OF THE MECHANICAL ENGINEERS; INSTITUTE OF MINING ENGINEERS; INSTITUTE OF ELECTRICAL ENGINEERS; ENGINEERS' CLUB OF NEW YORK:

It will give me great pleasure to devote, say, one and a half million of dollars for the erection of a suitable Union Home for you all in New York City. With best wishes, truly yours,

(Signed) ANDREW CARNEGIE.

The Union Engineering Building, therefore, is assured. In addition to the $1,500,000 contributed by Mr. Carnegie for the erection of the building, the four societies named have invested over half a million dollars in land for the site of the building. The Union Engineering Building will probably be twelve stories high and will contain four or five auditoriums of different sizes, one of which will contain a seating capacity of 1500. All of them will be appropriately equipped for scientific meetings, lectures and demonstrations. There will be an engineering museum and a magnificent library hall where the libraries of the several organizations will be grouped and consolidated, each section being administered by the librarian of the society owning it. The societies, of course, will in no way be consolidated; each will maintain its identity and autonomy and will have individual quarters in the building. The representatives of the four bodies which have been made the beneficiaries of Mr. Carnegie's splendid gift, are as follows: F. R. Hutton, C. W. Hunt and J. M. Dodge, from the American Society of Mechanical Engineers; Dr. A. R. Ledoux, Theodore Dwight and C. Kirchhoff, from the American Institute of Mining Engineers; Charles F. Scott, Dr. S. S. Wheeler and Bion J. Arnold from the American Institute of Electrical Engineers; J. C. Kafer, W. H. Fletcher and T. C. Martin, from the Engineers' Club.

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Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

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Predetermining Solenoid Performance.

Anyone who has ever attempted to make a solenoid to do a predetermined amount of work, using the familiar traction law as the basis, has made the unpleasant discovery that the traction law does not apply even remotely when there is an air-gap of appreciable length. Of course, this fact is well known to those versed in electromagnetic theory, and it has also been well understood that the pull of a solenoid or electromagnet at any given position of the armature or plunger is directly proportional to the increment of flux increase per increment of movement that would result from such movement. The application of this latter principle to actual practice, so far as we are aware, is explained in print for the first time in Mr. Del Mar's article in this issue. In order to make his deductions conform perfectly with the fundamental laws governing the case, Mr. Del Mar has used the calculus in presenting the analysis of his reasoning, but it is not at all necessary to use calculus in applying his method to practical work, as he himself indicates by taking arithmetical averages over small distances instead. Where a close approach to accuracy is essential, the distances should be very small, of course.

The method of obtaining the flux gradient by calculating the individual reluctances of the different parts of the magnetic circuit for each position of the plunger might be somewhat simplified by using suitable constants instead of reducing the dimensions of the circuit to metric measure, or by making the solenoid parts all to standard metric measure, as one prefers; but probably the most practical method would be to work in terms of ampere-turns per inch length of path required at given densities. The whole procedure is necessarily of the cut-and-try character, so that it would be as expeditious to work from curves showing the exciting force per inch of length required at different magnetic densities as to use permeability curves and reduce from English to metric measure to ascertain the reluctances. The "gradient" method has the disadvantage of being non-reversible; one cannot assume the pull desired and solve the gradient formula for ampere-turns. Nevertheless, it is far superior to the guess-work that is entailed by attempting to predetermine solenoid characteristics without applying this method.

It should not be overlooked that the success of the gradient method depends on the practicability of calculating the magnetic flux that will be produced by a given excitation with the movable member of the system in a given position. The longer the air-gap, the more spreading of magnetic lines there will be, even when the air-gap is entirely enclosed in the exciting coil, as in the type of solenoid considered in Mr. Del Mar's article. If the apparatus is an ordinary electromagnet, the spreading will be very much greater, and it is practically impossible to estimate the reluctance of the air-gap with any approach to accuracy; moreover, magnetic leakage around the outside of the magnet coil or coils, which cannot be even approximated by computation, would vitiate any calculations based on the theoretical flux in the air-gap. The method, therefore, does not appear to be applicable to any case except that of a solenoid in which the exciting coil completely encloses the air-gap and the length of the latter is small in comparison with the length of the coil along its axis. Since most modern solenoids are of exactly this type, however, for the reason that it is the most efficient, the gradient method should be of much practical value, notwithstanding its shortcomings when applied to other types of electromagnet.

The Union Engineering Building.

As noted in another column, Mr. Andrew Carnegie just before his departure for Europe completed the details of his splendid donation to the engineering profession. While the electrical, mechanical and mining national engineering associations are the direct beneficiaries of Mr. Carnegie's generosity, all engineering and scientific organizations that may desire to establish headquarters in the new building will share the benefits with the societies mentioned. In fact, one of the reasons for the delay in putting the terms of the benefaction in final form was Mr. Carnegie's desire to learn whether or not the proposed establishment would be a union engineering building in reality as well as in name. The result of an investigation on this point has been extremely gratifying, numerous representative engineering and scientific bodies having made formal application for quarters in the proposed building.

In addition to furnishing a suitable home for the principal engineering societies whose headquarters are in New York, Mr. Carnegie's gift will undoubtedly have the effect of promoting closer affiliation and co-operation between these bodies by reason of the intimacy of association which will result from joint occupancy of the Union Building. Moreover, this intimacy of association will not only tend to strengthen the cordial relations already existing between the several organizations and facilitate the furthering of interests which they have in common, but it will undoubtedly develop and enhance personal friendliness between individual members of the societies. These latter features alone will more than justify Mr. Carnegie in his latest benefaction to science and engineering.

Manual vs. Automatic Telephone Exchanges.

The article on this subject which we print elsewhere in this issue can scarcely fail to impress the unbiased reader as a very clean-cut, impartial discussion. There are many points of advantage on both sides, and while Mr. Knowlton seems to think that the preponderance thus far is on the side of the manually-operated exchange, it cannot be said that his argument is at all partisan. The fact that the automatic class of exchange has made conspicuous headway during the past few years, and the lively interest in that type of apparatus which the Bell organization is manifesting, are strong evidence that the automatic exchange is entitled to very serious consideration. On the other hand, as Mr. Knowlton points out in detail, one must "go slow" in adding to the routine which a subscriber has to follow in obtaining a connection with another subscriber. The present central energy systems are marvelously simple so far as the amount of effort imposed on the calling subscriber is concerned; in compensation, of course, there are the too familiar annoyances incident to conferences between irascible subscribers in a hurry and pert telephone operators laboring under an exaggerated sense of their own importance.

It would seem that the most serious obstacle to be overcome in automatic exchanges is the difficulty in obtaining long-distance connections promptly. A mixed automatic and manual system would, of course, be necessary to a solution of this problem, and while such a mixed system might develop some extremely troublesome features at first, there seems to be no good reason why these cannot be eventually eliminated. The drawback of imposing upon the subscriber the work of setting up the number he wants to call might be serious in very large exchanges, but it could be reduced to practical insignificance in those of moderate and small sizes. However, the question cannot be discussed satisfactorily in the absence of complete reports of the results obtained with automatic exchanges in practice; many difficulties apprehended from theoretical considerations may never develop at all, and many "snags" which could never be predicted or even suspected will certainly crop out under conditions of daily practice. This is true of all classes of invention.

Power Factor.

Although the meaning of the term "power factor" has been explained in this part of the paper two or three times and was briefly discussed in the Lessons Department last month, the receipt of many letters asking for information on the subject moves us to explain once more than the "power factor" of an alternating-current circuit is the number by which the apparent power in the circuit must be multiplied in order to ascertain the actual or true power, in the absence of an instrument which will indicate the true power. The power factor is always a number less than unity; when the apparent power and the true power are identical, the circuit is commonly said to have a "power factor of unity," but logically it has no power factor for the reason that there is no need for the use of one except when there is a discrepancy between the apparent and the true power.

When an alternating-current circuit contains inductance, the current lags behind the e.m.f., and when it contains capacity the current rises ahead of the e.m.f.; in each case the current and e.m.f. reach their maximum values at different instants, and the product of e.m.f. and current ($E \times I$) at any instant is less than it would be if the two were in phase with each other. If the e.m.f. and current be measured separately, the voltmeter and ammeter will give the individual mean effective values; if they are measured by a wattmeter, the instrument indicates the combined effect of the two synchronously, not the product of their mean effective values, which occur at different instants. Consequently, the wattmeter indication is less than the product of the separate voltmeter and ammeter readings; the ratio of the former to the latter is the power factor of the circuit.

Assume, for example, that a voltmeter and an ammeter connected up at the terminals of an induction motor indicated 200 volts and 120 amperes, and a wattmeter connected at the same point indicated simultaneously 21.12 kilowatts. The product of the voltmeter and ammeter readings would be 24 volt-amperes, and the power factor of the motor, with the load then being carried, would be $21.12 \div 24 = 0.88$, or 88 per cent. This would mean that the current lagged behind the e.m.f. to such an extent that when the latter was at maximum, the current was only 88 per cent of its maximum value; or, when the e.m.f. was actually at its mean effective value, the current had reached only 88 per cent of its mean effective value. On the assumption that the current wave follows the sine law, this would indicate that the current lagged almost exactly 0.08 of a cycle behind the e.m.f.

Lighting Electric Cars.

It is a matter of common knowledge, of course, that the lights in an electric car operated on a sub-surface conduit system are extinguished momentarily whenever the car passes a switch or a crossing. This is one of the minor disadvantages of such a system which are not worth the expense of correction. The momentary disconnection of the car circuit from the working conductors in the conduit is due to the necessary break in the conductors where they meet other conductors of opposite polarity, and there is no practical method of avoiding this break when a track separates into two curves turning in opposite directions to enter another track at right angles to the first one. At almost all other points the disconnection could be avoided by using two plows on each car, so that one of them would always be in contact with the conductors; but such an arrangement would cause a short-circuit on the system when the car passed the Y junction between two tracks at right angles, just mentioned.

In view of these well-known facts, it is somewhat difficult to identify the system of "wiring" an electric car to which the *New York Times* referred recently as affording a simple cure for the blinking of the lights under the conditions named. According to this technical authority, such a system has been in use in Europe for some time and has been "installed, after a careful test, on the electric street railway system of Scranton, Penn." The Scranton Railway Company states that it is all news to them, and we confess it would be a revelation to us to find that any method of wiring a car could prevent the lamps from going out when the car circuit is disconnected from the supply source. Some genius may have "invented" a system of small storage battery cells to be carried by each car for the purpose of keeping the lamps bright during breaks in the supply connections, but of course an authority of the *Times'* standing could not confuse a storage battery with a system of wiring.

CONSTRUCTION OF A 2-H. P. MOTOR OR 25-LIGHT INCANDESCENT DYNAMO.

BY F. C. MASON.

The accompanying drawings are for a direct-current motor of which the writer has built several; all of these run smoothly, without any sparking or overheating whatever. Fig. 1 is a sectional elevation showing practically the whole construction, and Fig. 2 is an end elevation with the journal bracket partly broken away and the field magnet partly sectioned to show the other view of the pole-piece and armature core.

The field magnet yoke ring is of cast steel, with the magnet poles or cores cast integral; the pole-pieces are also of cast steel and are held in place by bolts extending through the centers of the cores from the outside of the yoke ring. The four pole-pieces are intended to be cast together with thin webs, say ¼-inch, connecting them; this will give a circular casting with four circular "bosses" equidistant around the outside, these "bosses" being the magnet core extensions. In machining the pole-piece casting, it should be chucked by the polar extensions in a four-jaw chuck, the "bosses" turned to a light driving fit in the 9-inch bore of the cores cast with the yoke ring, and the pole-faces bored to 7 inches diameter. Then the connecting webs must be cut away and the corners of each pole-piece rounded to ¼ inch radius. Next, the hole for the retaining bolt should be drilled precisely in the center of each pole-piece and tapped for a ⅝-in. cap screw.

The machine work on the field magnet frame is simple. The frame is first strapped to the face-plate, the magnet core ends bored to 9 inches diameter, and the exposed edge of the yoke ring faced off and recessed for the journal bracket ring; then a supplementary face-plate must be made which fits snugly in the recess for the bracket-ring, this plate bolted to the face-plate of the lathe so that its center coincides precisely with the lathe center, and the magnet frame again strapped to the lathe face-plate with the unfinished edge outward this time, the supplementary face-plate entering the bracket-ring recess in the finished edge and thereby centering the magnet frame with its former position. Then the exposed edge of the yoke ring is faced off and the recess cut for the other journal bracket ring. The holes for the ⅝-in. cap screws which retain the magnet pole-piece in place should be ¾ inch in diameter, so as to allow ample clearance for adjusting the pole-pieces to equidistant positions in case the magnet cores of the yoke ring are not precisely equidistant. These holes should be laid out with extreme care, so that their centers will be precisely 90 degrees apart and all of the holes will be absolutely radial to the machine frame. After this is done the feet may be faced off on a planer or milling machine to fit in the base shoe, Fig. 3. The fit should not be too snug; the machine should slide freely in the shoes.

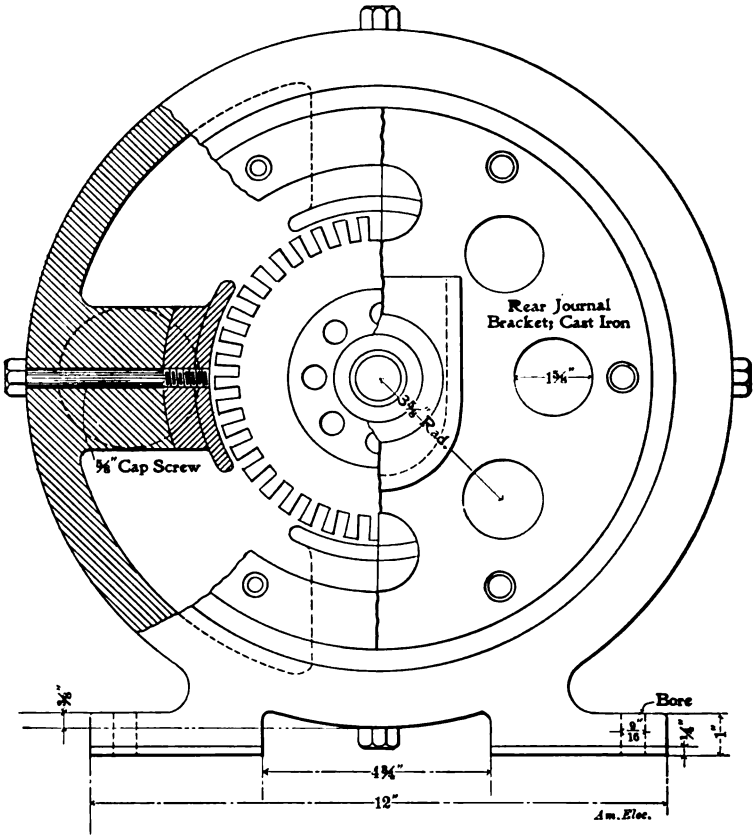


FIG. 2.—SEMI-SECTIONAL END ELEVATION OF MOTOR.

The journal bracket-ring for the commutator end of the machine is shown by Fig. 4. The design is quite simple, so that explanation is unnecessary. The bracket-ring for the pulley end of the machine is shown with sufficient completeness in Figs. 1 and 2. It is practically a dished disc with eight 1⅝-in. holes cored in it for ventilation; the centers of these holes should be 3⅝ inches from the center of the shaft hole. In machining the brackets probably the best plan would be to drill the hole for the shaft bushing first and mount the bracket on a mandrel, bracing it from the inside by means of a disc of cast iron about 8½ inches in diameter, also mounted on the mandrel and pushed up against the curved portions of the bracket

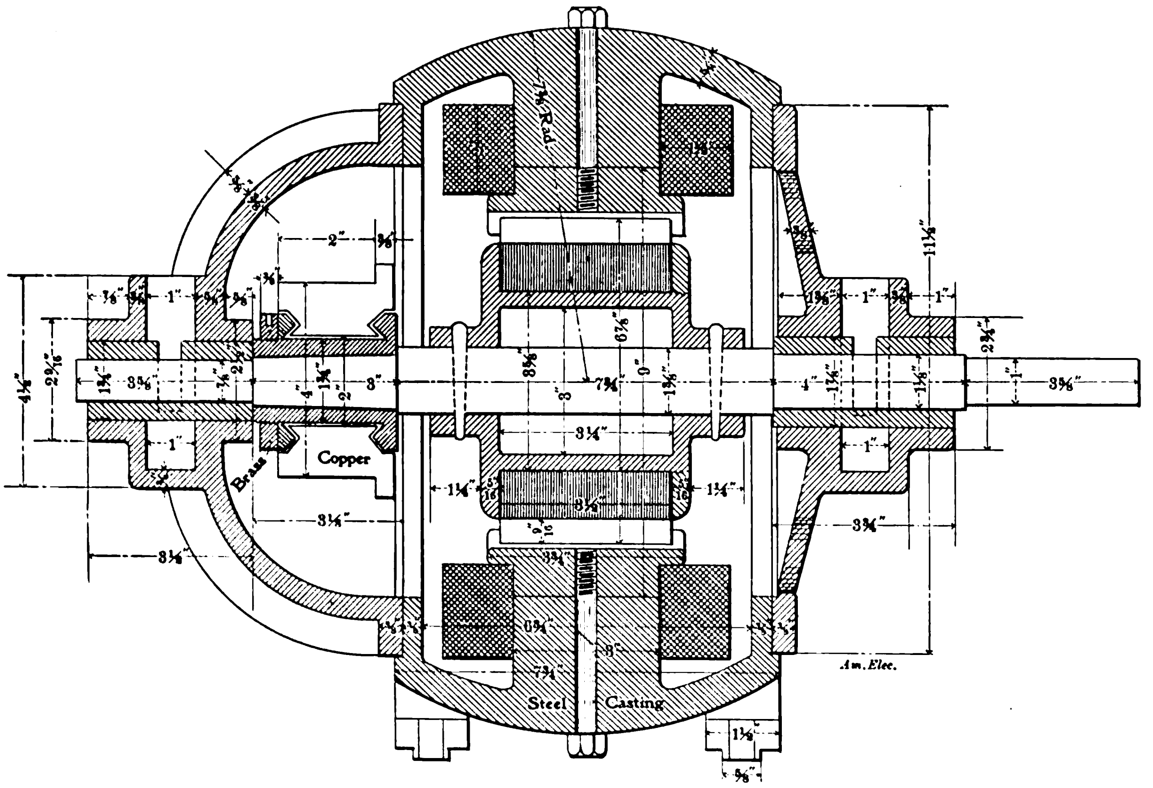


FIG. 1.—SECTIONAL ELEVATION OF 2-H.P. MOTOR.

yoke. The internal circular edge of the bracket ring does not need to be finished off, but it is better to take a little cut off that edge for the sake of appearance.

The bearing bushings (see Fig. 5) may be made either of hard brass or phosphor-bronze, preferably the latter. Each bushing should be bored out first and then mounted on a mandrel and finished on the outside. The oil groove at each end may be tooled out when the bushing is bored or afterwards, as may be most convenient for the builder. The oil ring slot is preferably cored out and cleaned up with a fine file afterwards, but if the builder finds the pattern making troublesome the bushing may be made solid and the oil ring slot cut out after the bushing has been trued up inside and out. Fig. 6 shows the oil ring dimensions.

It will be noticed from Fig. 1 that the shaft is ⅞ inch in diameter in the bearing at the commutator end and 1⅛ inches in diameter in the bearing at the pulley end. On this account, and also because of the greater side thrust at the pulley end, the two bushings are not identical, the one in the bearing at the pulley end being longer as well as larger in diameter than the other. The shaft can be made of machinery steel, but it is preferable to make it of low-carbon tool steel. If the latter material is used, the shaft should be rough-turned first to within 1-16 inch of the final diameter. It should then be heated to a dark red and allowed to cool; after cooling, it should be turned down to the required size. This process leaves the shaft straight in a semi-annealed state without any internal stresses, and it will always remain so.

The armature is of the usual slotted drum type and the discs are mounted on a cast-iron spider, which is pinned to the shaft as shown in Fig. 1. The discs must be of the very best grade of electrical steel and should be about No. 20 gauge. If the builder has no facilities for stamping out the discs, the core may be made by cutting sheet steel into squares about 7⅛ inches each way, having the center holes punched out at some shop where proper facilities are available, and mounting the square sheets on a mandrel, clamping them between two cast-iron or wrought-iron discs 6⅞ inches in diameter.

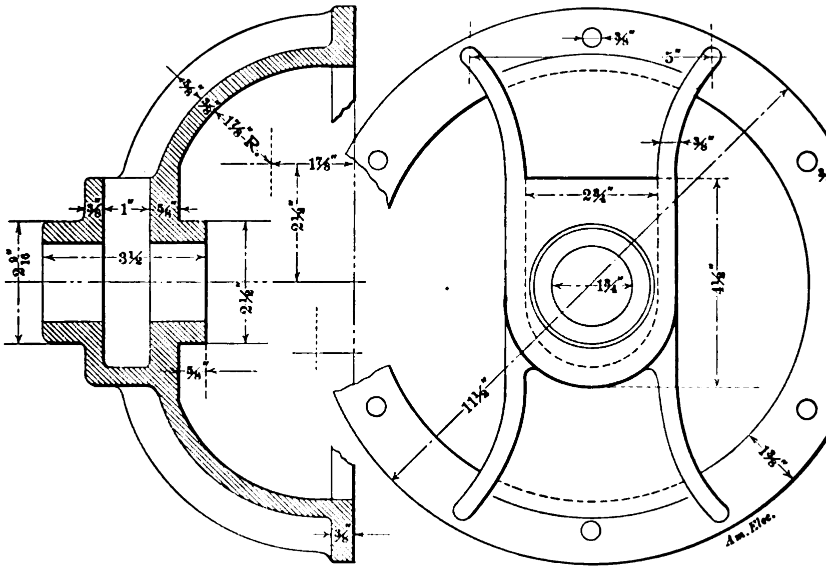


FIG. 4.—JOURNAL BRACKET RING; COMMUTATOR END.

The sheets can then be turned down to circular form of the proper diameter, starting the tool in the flat face of the mass and not attempting to turn off the corners with a radial tool. The center hole in each plate should be punched out with a keyway, so as to avoid the possibility of the discs turning on the mandrel or on the armature spider, as well as to facilitate assembling them accurately on the spider.

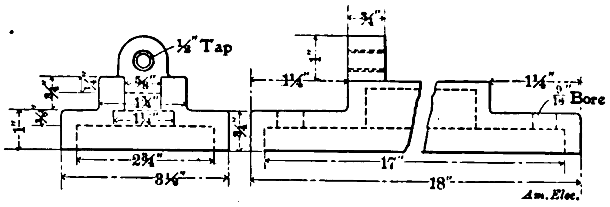


FIG. 3.—BASE SHOE.

After the core is turned to its circular form, the slots may be cut on a milling machine. If oil is used in order to expedite the work of milling out the slots, the discs must be thoroughly cleansed from the oil afterwards. This may be done by the use of gasoline, or better still, by a hot potash solution. After cleaning off the oil, the discs should be varnished with shellac or some armature insulating compound on each side.

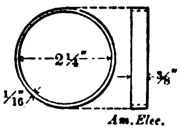


FIG. 6.

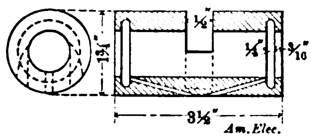


FIG. 5.—BEARING BUSHING.

They are assembled on the armature spider with a disc of hard fibre 1-16 inch thick at each end of the core. These discs should extend to the outer diameter of the core discs, and it is advisable to that end that they should be assembled with the core discs when these are put on the milling machine for cutting the slots, so that the slots will be cut in the fibre discs also. The armature spider or drum is fastened to the shaft by No. 6 standard taper pins. The writer has found this method easier and more satisfactory than the use of keys.

The armature slots must be provided with troughs of material 1-64 inch thick; the material may be hard fibre, press board, mica or flexible micanite. Mica is, of course, the best material so far as insulation is concerned, but micanite is preferable from all-round considerations as it withstands mechanical strains better than the pure mica.

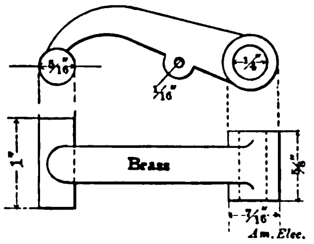


FIG. 9.—BRUSH HOLDER FINGER.

If the troughs are made of flexible micanite, the builder can very easily shape these to fit the slots by means of a simple former of hardwood, consisting of a block with a slot exactly the size of the armature slot and a strip of wood the thickness of which is 1-32 inch less than the width of the armature slot. The strip constitutes a male die to press the micanite into the slot in the block.

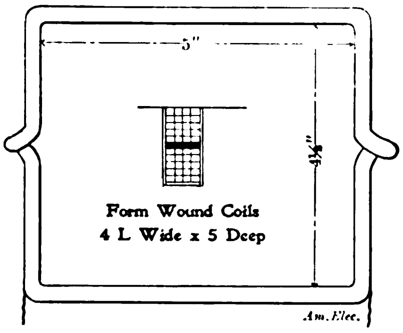


FIG. 7.—ARMATURE COIL.

The armature coils are intended to be form-wound and the dimensions of the former are given in Fig. 7. The armature coils for 110 volts consist of 20 turns of No. 16 double cotton-covered wire; for 230 volts, each coil has 40 turns of No. 19 wire. The ends of each coil should be left about 8 inches long for connection to the commutator, and these should be covered with cotton sleeving just large enough to slip over the wire comfortably and long enough to extend into the coil about ½ inch. After putting on the sleeves the coils should be taped with a single wrapping of German linen tape, half lapped. After painting the coils with fairly thick shellac or armature insulating compound, they should be allowed to dry just enough to allow ready handling, but it will be found easier to assemble them on the core if they are put in before they are entirely dry. There are forty-seven coils and forty-seven slots, and each coil should embrace twelve core teeth. The terminals of each coil are connected to commutator segments between which there are twenty-two other segments, or in the armature winder's parlance, each coil is connected up "1 and 24." If the builder has had no experience in armature winding and connecting, it will pay him to secure the services of an armature winder to assist in this work.

The commutator is the most difficult part of the motor to build successfully. Copper segments suitable for this machine can be obtained from any one of several manufacturers. Drop-forged segments are the best, but cast copper may be used. The dovetail part of each segment does not need to be precisely as the drawing shows it. The best method is to obtain catalogues from the various makers of commutator segments and commutators and select the stock segment which comes nearest to the shape and dimensions shown in the drawing. The commutator core or shell and clamping collar will, of course, have to be made to suit the size and shape of the segment selected. The micanite strips between the commutator segments should be 30 mils thick, and the rings insulating the dovetail part from the beveled collars should be at least 1-16 inch thick, and preferably 75 mils. For assembling the commutator a drawing-down ring should be made of machine steel about ½ inch larger in inside diameter than the external diameter of the commutator barrel. Two rows of set screws should be tapped into this ring so that the screws will point to the center of the ring, and the two rows should not be staggered. As many screws should be put in each row as space will allow. The commutator segments and mica strips are assembled inside this ring, each segment and strip being shellacked as it is put in place. Then the set screws should be tightened up evenly all around, each screw being given only a part of a turn at a time until all of the screws are tight and the commutator segments have been forced into an approximately cylindrical shape. Then the commutator should be baked until the shellac is thoroughly hard, after which the inside circle of the segments should be trued up and the circular beveled end faces machined to size. Then the segments, with the clamping ring still in place, are transferred to the commutator shell or core and clamped tightly between the beveled collars, the core, of course, having been previously machined to size. The final work consists merely in turning off the outside of the commutator barrel and the lugs, which may be done by mounting the commutator structure on a mandrel and driving the mandrel by a lathe dog. The slots in the commutator lugs for the armature wires should then be cut either by a thin saw on the milling machine or by means of a hack saw, preferably the former.

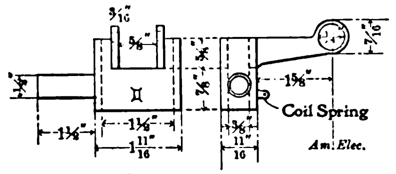


FIG. 8.—BRUSH HOLDER.

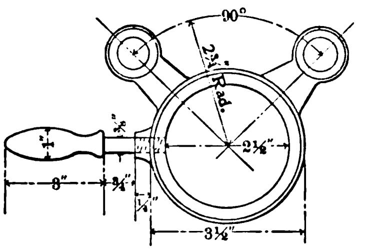


FIG. 10.—BRUSH YOKE.

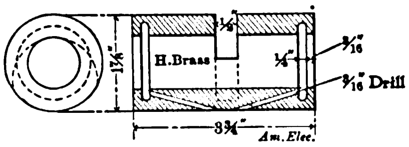


FIG. 11.—BEARING BUSHING.

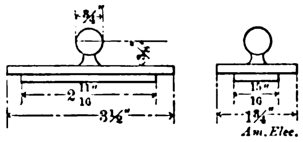
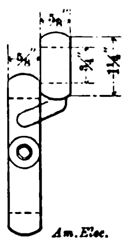


FIG. 12.—OIL WELL CAP.



After testing up the winding and commutator for grounds or other defects and clearing out any troubles which develop, the binding wires may be put on the armature. This should be of No. 18 hard brass wire and should be wound over a layer of pure mica. Three sets of binding wires about ½ inch wide should be used, one around the middle of the core and one near each end.

The field-magnet coils should be wound on spools of either fibre or mica, and the coils should all have exactly the same number of turns of wire. The magnet coils for the 110-volt machine are of No. 12 wire, and those for the 230-volt machine are of No. 27 wire. The dimensions shown in Fig. 1 indicate the inside dimensions of the spools. If the winding is carefully done the builder will be able to get from 3000 to 3100 turns of No. 23 wire in each coil. It will be impossible to wind the No. 27 wire in smooth layers, but this should be approximated as closely as possible. The starting end of each coil should be marked by a tag or other means, and when the coils are put in place they should be assembled with the ends of the spools through which the inner ends enter all turned toward the armature. It will then only be necessary to remember that the inner end of any coil must be connected to the outer end of the neighboring coil in order to magnetize the cores properly.

The brush-holders are of the simple box type, as shown by Fig. 8; Fig. 9 shows the feeding finger which presses the carbon brush on the commutator. The holders must, of course, be insulated from the quadrant or yoke by means of fibre washers.

The speed of the machine is approximately 950 r.p.m. It may be used either as a 2-h.p. motor or as a shunt-wound dynamo; it will have a capacity of about 25 16-c.p. lamps when driven as a dynamo. The speed, of course, will need to be a good deal higher than the motor speed; 1000 to 1025 r.p.m. will be sufficient. The starting box for the motor should be purchased from one of the standard manufacturers, and this is also true of the field rheostat if the machine is used as a dynamo.

THAWING FROZEN WATER PIPES ELECTRICALLY.

BY WALTER M. PETTY.

The thawing out of frozen water pipes by means of electricity was first suggested in 1900, but not until this year has the idea been put to practical use, so far as the writer is aware. The winter being so very severe in the vicinity of New York, an unusual number of house-holders have been the sufferers by reason of the freezing up of the service pipes, and in the suburban towns this has been particularly noticeable. The writer found in one instance that the frost was in the ground to the depth of 3 ft. 9 ins. As all, or nearly all the pipes do not lay in the ground much below this depth, it is easily understood why so many have been frozen.

To Mr. Walter P. Schwabe, Superintendent of the Rutherford District of the Gas & Electric Company, of Bergen County, N. J., should be given the credit of first employing on an extensive scale the heating effect of the current for the purpose of thawing out frozen pipes. Mr. Schwabe used two 10-kw. oil insulated transformers, connected in multiple, and stepping down from about 2400 volts to about 55 volts. A water rheostat was used to control the primary current and an ammeter was put in the primary circuit. The whole outfit was mounted on a wagon drawn by one horse, and three men were employed to do the necessary work. As all the wires in Rutherford are overhead it was a simple matter to connect the primaries of the transformers to the commercial lines by sending a man up the nearest pole. Heavy leads composed of No. 0 cable were then clamped on to the water service pipe requiring thawing, in the cellar of the affected house, and the other to the service pipe in the nearest cellar. The circuit through the primary was closed by means of the water rheostat, and in about one minute a perceptible heating was noticed in the pipes. This increased until water flowed. The time required from the closing of the circuit until the water flows varies from three to twenty minutes, the average being about ten.

The average length of the service pipes thawed out was 50 feet. As nearly all these services are made of lead pipe, the resistance in all cases is about the same, namely, 0.15 ohm. Occasionally, however, an iron service pipe was encountered, and the effect of the increased impedance was felt. At such times the ammeter in the primary registered about 5 amperes, and the melting took longer. The rusty joints of iron pipe also increased the resistance somewhat. Even under these circumstances not a single failure has been experienced.

The average current in the primary circuit was 9½ amperes; this would mean in the secondary about 460 amperes. The amount of power required is obviously in the neighborhood of 20 kilowatts, in round figures.

This method is so far superior to that of excavating the street and is so sure that the electric light company has been overwhelmed with orders. One gang of men can do about twenty jobs in a day. Whenever two houses in the same neighborhood are frozen, as often happens, they can be thawed out at the same time.

One of the peculiar facts noted is that whenever it takes longer than the average the first flow of water brings with it a quantity of sand sediment, which must act as a plug. The thawing serves as a cleansing agent as well.

In taking bridge measurements in order to ascertain the resistance of the house services, the writer found at times that he was unable to get a balance. Upon testing with a low reading voltmeter it was found that there existed a difference of potential of 0.133 of a volt between adjacent houses. There being no trolley line within a distance of half a mile, it cannot be caused by leakage from the trolley circuits. Possibly the fact that the street mains are of iron and the services of lead may account for this flow of current.

[In addition to the foregoing, Mr. Schwabe informs us that he found it advisable to disconnect the service pipes from the consumer's house piping and let out the ice and sand before discontinuing the application of the thawing current. When this was not done, the sand and ice in the pipe choked the flow of water so that it froze again. In one case a run of 525 feet of galvanized iron pipe was thawed out; this required the transformer secondaries to be connected in series so as to obtain 110 volts in the secondary circuit. The current required for this case was about 260 amperes and the thawing took 45 minutes; the secondary leads were clamped to the service pipe in the consumer's cellar and to the nearest fire hydrant.—EDITOR.]

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HINTS FOR WIREMEN.

BY ELMER E. WARNER.

Every age and trade has its superstitions. From time immemorial the left hind foot of a rabbit has been regarded by some persons as an infallible charm against all evils. Like the rabbit's foot, sheet asbestos has become a sort of fetish with some electrical wiremen, who seem to think that any electrical appliance backed up by a piece of this mysterious substance immediately becomes immune.

Taking a thirty-ampere Edison plug cut-out as an illustration—as perfect an appliance as is used in the trade—the cautious wireman will nail up against the wall a scrap of flooring and over this carefully double a sheet of 1-32 inch asbestos, upon which he screws his cut-out block. Any kind of rheostat, switch or controller is considered safe with a backing of this sort.

Tracing back, one finds these traditional observances originating in the early days of rules and regulations for installation work, when appliances were imperfectly insulated, which is rarely the case now. Rheostats have metal frames and backs and projecting feet, giving air space behind. The rules require it. What is needed is intelligent discrimination.

But after all there may be method in the madness of the wireman, for asbestos is cheap and may cover the roughest sort of wood butchery. It is indeed, in many cases, a sort of electrical upholstery. The writer has more than once found panel boards, made from rough scrap lumber gathered on the premises, clothed to a semblance of respectability by a layer of this material—even raisin and fig boxes thus transformed and doing duty as panel boxes. However neat in appearance at first, asbestos readily absorbs dust and is likely to become ragged as well as discolored. It is, in short, fragile and impermanent. Small fireproofed boards for assembling cut-outs, switches, etc., neatly molded with extra separable batons, could be furnished to small contractors, if made up in quantity, at less than their makeshift backings cost them now. Two or three sizes would cover the bulk of their work and give an appearance of finish lacking now.

Every wireman owes it to his employer to make himself as little of a nuisance as possible. The customer need not be an expert to appreciate neatness in workmanship or politeness in manner or quickness and care in cutting through floors and walls and getting up his wires. And just here it is not amiss to mention floor bushings. The ordinary porcelain tubes in many cases are not set close to walls or do not meet the moldings. Whereat the wily wiremen who does not carry a lumber yard with him, hunts around in the cellar for some remnant of a packing case and laboriously builds up around them a box which is not only a disgrace to himself but literally a stumbling block in the path of others. Now, a piece of conduit, or plain iron pipe even, is cheaper and better.

Pending the time when all risers will be allowed only in conduit, such a bushing of pipe carried at least to the top of the baseboard and strapped to it, with each conductor encased in loom projecting from the pipe and extending continuously from molding to molding, makes a first-class and neat job. Pipe is particularly desirable where walls are stepped off or partitions are not directly on line, because it can be curved in the floor spaces, avoiding offsets or projections above the surface of the floor.

The best of things may be run into the ground, and it may be well to remember that such an excellent protector as circular loom and similar conduit has its abuses as well as its uses. As a passageway for concealed wires in finished buildings of the cheaper class, it is excellent if continuous between outlet boxes and well secured in the boxes. As an extra insulation for use on open wires where pipes are crossed or branches are taken off and wires of opposite polarities cross, it also has a legitimate function. But when inserted in molding work to have mitering or neatly fitting the molding around projections and corners, it makes a piebald, discontinuous, disreputable job. As many as ten breaks of this sort may often be seen in a hundred-foot run of what would otherwise be very creditable work. Even when dropping down from the ceiling past a very elaborate wood or metal cornice, it is better to go through and *behind* in circular loom projected into the gouged ends of the molding than it is to break around outside, and in many such cases it is possible to cross cheaply by using molding with a stout backing strip fitted at the ends into the cornice. One should be consistent above all things, and whatever the system of wiring adopted, stick to it throughout.

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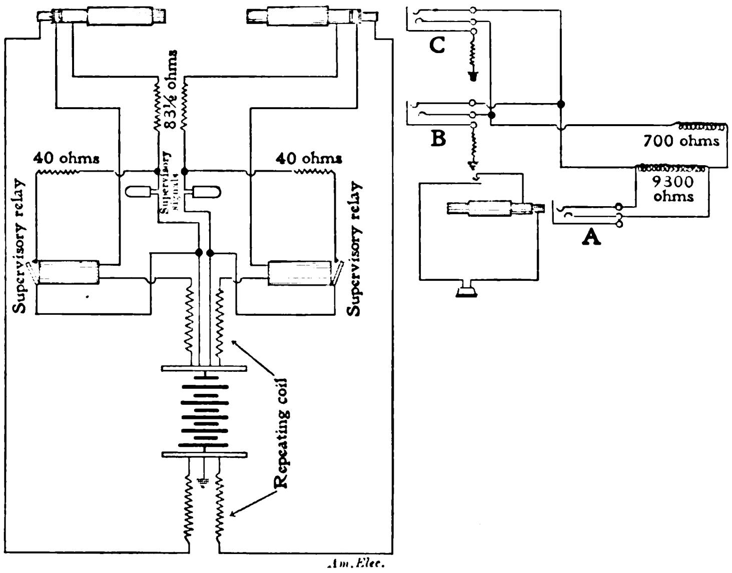
SOME AIDS IN THE MAINTENANCE OF COMMON-BATTERY CENTRAL OFFICES.

BY A. DALLAM O'BRIEN.

In the modern common-battery central office, with its multitude of more or less complex circuits and its great number of delicately adjusted relays, the problem of satisfactory maintenance is far from being a simple one, and the engineer is called upon to exercise considerable ingenuity in order to overcome the numerous troubles to which the equipment is subject. It is of the greatest importance in central-energy systems that the line insulation resistance should be maintained as high as possible, as with lines of this kind a leakage that would probably not prove serious in a local-battery or magneto system will in common-battery installations be sufficient to operate the line signal and thus, so far as the connected subscriber is concerned, render the line inoperative. It is the customary practice in central-energy exchanges to make an insulation test on all the lines connected to the exchange at least once every twenty-four hours and to note all cases which show defective insulation and have each case of trouble followed up and cleared by linemen at the earliest possible moment.

There is one class of trouble to which the three-wire, and indeed the two-wire, common-battery system is especially subject and which is the cause of considerable annoyance to subscribers and no inconsiderable expense to the telephone company. The trouble referred to is that due to defects in the connecting cords at the switchboard. The defect may be a short-circuit, an open conductor in the cord, or an intermittent make and break of the circuit usually termed a "cut-out." This last-mentioned form of trouble is probably the most aggravating defect in the service that the subscriber comes in contact with, and it forms the basis of almost an infinite number of complaints.

It is a difficult if not an impossible feat to entirely eliminate defects in the connecting cords, even though every possible precaution is taken. In order that connections may be handled with a reasonable amount of rapidity by the operators, the cords must necessarily be flexible, and with the present switchboards the plug in which the cord conductors terminate must be rigid in order that it may make contact properly with the springs of the jack. It is at the point where the flexible cord enters the base of the plug that the defects referred to show up and they are directly due to the handling of the cords by the operators. If it were possible to train operators so that when placing a plug in a jack they would hold the plug firmly without allowing the hand to come in contact with the cord, it is probable that troubles of this nature would be very largely decreased. The tendency, however, during busy periods is for the operator to insert the plug part way in the jack and then push it in the rest of the way by pressing on the end where the cord enters, in this way straining the conductors and in time damaging them.



Am. Elec.

FIG. I.—DIAGRAM OF CONNECTIONS FOR LOCATING CORD CIRCUIT TROUBLES.

In addition to the troubles already mentioned, there is another fault to which the cord circuit is subject, namely, the false operation of the supervisory signals, this being due to the improper adjustment of the supervisory relay. The relay may stick, due to low insulation resistance on the line; or the armature, not being properly adjusted, may fail to fall upon disconnection of the circuit and thus necessitate supervision on the part of the operator. A thorough test of all the cord circuits for cut-outs, opens and short-circuits, and for relay adjustment is made once every twenty-four hours. In addition to this, cases of trouble which show up before the test are at once taken up and cleared by the maintenance force.

The diagram in Fig. 1 shows a very common arrangement in use for testing and locating cord circuit troubles. For this arrangement it is necessary to use three of the multiple jacks throughout the switchboard, the third wire or sleeve strand of two of these jacks being connected to ground through a 30-ohm resistance coil; the sleeve strand of the third jack is left unconnected. The jacks are located so that *A*, as shown in the diagram, appears as near the center of each switchboard section as possible, while jacks *B* and *C* are located one at either end of the section. A 9300-ohm resistance coil is connected across the line terminals of the jack *A*, and in series with this coil is connected a 700-ohm resistance, the free end of which is connected to the tip springs of the jacks *B* and *C;* the ring springs of the three jacks are connected together, as shown in the diagram. The cross connections of the jacks and the connections to the resistance coils are usually made at the intermediate distributing frame. The tester is equipped with a head receiver wired in series with a strap key or push button and connected to the tip and ring contacts of a switchboard plug, the normal position of the strap key being that in which the circuit is broken.

In the operation of testing cord circuits, the cord to be tested is inserted in either of the jacks *B* and *C*, depending upon the position of the cord, and the tester's plug inserted in the jack *A*. The strap key being closed, current flows from the cord circuit battery through the supervisory relay to the ring of the test jack, thence through the tester's receiver and strap key and back through the 700-ohm resistance coil and tip of the plug to the cord circuit battery. If the supervisory relay is in proper adjustment, sufficient current will flow through the testing receiver and the 700-ohm resistance to operate it and thus close the 40-ohm shunt around the supervisory signal and extinguish the lamp; this, of course, should have lighted when the plug was placed in the test jack, its circuit being closed through the 30-ohm resistance coil to the ground. If now the strap key be closed, the current flowing through the supervisory relay of the cord under test can only return to battery by passing through the 9300-ohm and 700-ohm coils in series, and if the adjustment of the relay be properly made the current flowing in this last case will be so small that the relay will release its armature and the supervisory lamp will again light up.

By working the strap key and alternately throwing in the 700-ohm resistance and the combination of the 9300-ohm and the 700-ohm coils, the rapidity with which the relay armature responds can be ascertained and satisfactory adjustment made.

From the foregoing it will be evident that the supervisory relays are adjusted so as to attract their armatures when a resistance of approximately 750 ohms is in series with the relay winding and to release their armatures when the external resistance is increased to 10,000 ohms. The value of the external resistance through which the relay should operate will depend largely upon local conditions, as it is of course necessary that the supervisory signals be made to operate when the cord is connected to the longest line entering the exchange. If the relays are adjusted, as has been assumed in the case described, to operate through an external resistance of 750 ohms and an allowance of 650 ohms is made for the line resistance, assuming that the cable conductors are No. 18 B. & S. wire, the supervisory signals will operate satisfactorily over a line five miles in length, which is probably considerably longer than any line connected to the average central office. In using this test to discover defects in the cord conductors, the strap key is closed and the cord to be tested is manipulated and worked by the tester throughout its length. Should there be a "cut-out," it will at once be detected by the clicking in the receiver, and an open or short-circuited cord will show up by the absence of a click when the strap key is closed. With this method of testing, a large switchboard can be very thoroughly gone over in a comparatively short time, and where two men are employed, one to operate the strap key and receiver and plug up the cords and the other to remove defective cords and adjust relays, the time can be reduced considerably.

There are a number of troubles that occur on subscribers' lines, which are intermittent in their nature and are usually designated by telephone men as "swinging troubles." They are particularly frequent on lines which run for some part of their length overhead and which are consequently subjected to possible grounds, short-circuits and crosses with other wires. The swinging of a wire on a pole line during a wind storm may serve to ground it sufficiently well, by contact with some other conductor, to operate the line signal at the central office; the same effect may result from a cross between the wires of a metallic circuit, the resulting short-circuit operating the signal. In cases of this kind, where the signal is displayed at the switchboard and the operator upon answering the line receives no response, a report of "Signal In" is made to the wire chief and the work of clearing the trouble is left to him.

The wire chief's testing desk is provided with a number of jacks which are wired to plugs located at a switchboard position, these lines being termed "plugging-up lines." An operator is stationed at this position and is connected to the wire chief by means of a calling circuit so that the wire chief can at any time communicate with the plugging-up position. These lines are numbered at both ends, and upon receipt of a report of trouble on any subscriber's line the wire chief requests the operator at the plugging-up position to connect cord No. 1, for instance, to the line in question. This the operator does through the multiple jack, and thus the connection is completed through to the testing desk. The diagram in Fig. 2 shows the arrangement of the plugging-up line and its connection to a subscriber's line. By following up this circuit the operation will be made clear.

The operator at the plugging-up position, having been requested by the wire chief to connect cord No. 1 to line 400, for instance, places the plug of the cord in the multiple jack of the line and presses the button *A*. Current then flows from the battery through the winding of the relay *B* and the button *A* to ground, thus operating the relay and closing the circuit from the battery through the relay armature, the wire chief's signal lamp which is located under its jack on the test desk, the winding of relay *C*, through the wire chief's cut-out button to the sleeve of the plug, and thence through the line cut-off relay to ground. The relay *C* and the line cut-off relay are now both operated and the signal of the line in trouble extinguished; at the same time, the lighting of the wire chief's signal lamp notifies him that his request has been complied with and the line is ready to test. As the button *A* is only momentarily depressed in order to operate the relay *B*, this relay is kept in operative condition by means of a contact on the armature of the relay *C*, and current flows from the battery through the relay *B*, the contacts on the relay *C*, to the ring of the plug and thence over the line to the fault, thus keeping the relay *B* operated. At the same time an interrupted battery current through a repeating coil flows to the sleeve of the plug and thence to the jack sleeves of the line in trouble, so that an operator at any section of the board testing the line in question is notified of the fact that it is in trouble. When the wire chief tests the inner contacts of the jack springs at the testing desk are opened and a clear test circuit is obtained. By pressing the cut-out button, the wire chief can cause the line signal to light at the answering position and can ascertain from the subscriber's operator if the line shows clear. Upon the removal of the fault, the circuit of the relay, *B*, is opened, its armature released, the relay *C* rendered inoperative, and the line cut-off relay restored to its normal condition. In cases where the fault consists of a short-circuit, the current flowing through the relay *B* returns over the line and through the contact of the relay *C* to ground.

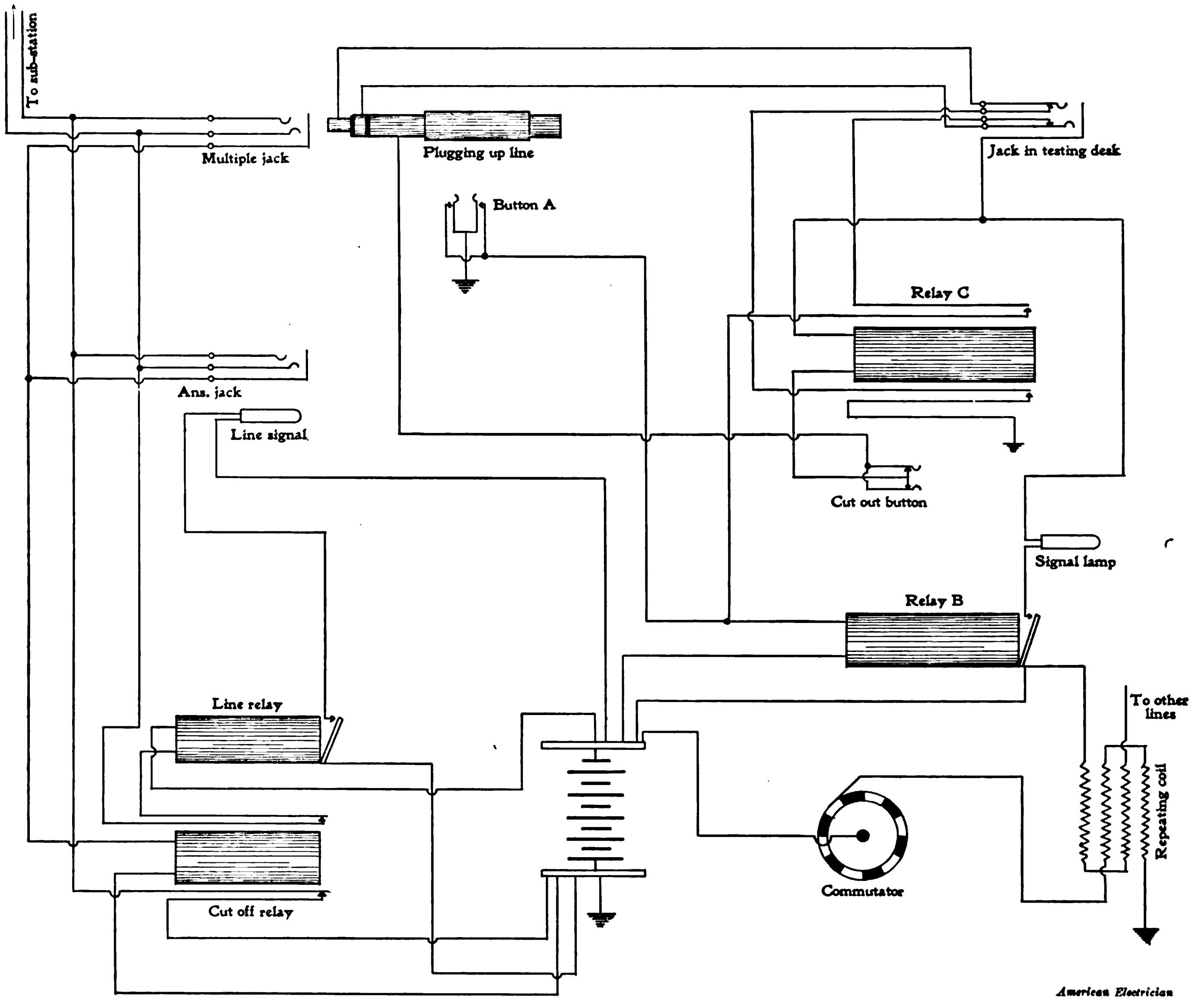


FIG. 2.—ARRANGEMENT OF PLUGGING-UP LINE AND ITS CONNECTIONS TO A SUBSCRIBER'S LINE.

It will be apparent from the foregoing description that the advantage of a test circuit of this nature lies in the fact that the line is cleared and ready for use the instant that the source of trouble is removed, and that it is not necessary for the lineman, or trouble hunter, to report to the wire chief in order to have the plugging-up line taken down and the cut-off relay restored. Promptness and despatch in clearing trouble on subscribers' lines is unquestionably of the highest importance in the operation of a telephone central office, and the necessity of a trouble "position," properly equipped with efficient plugging-up lines, has come to be thoroughly recognized.

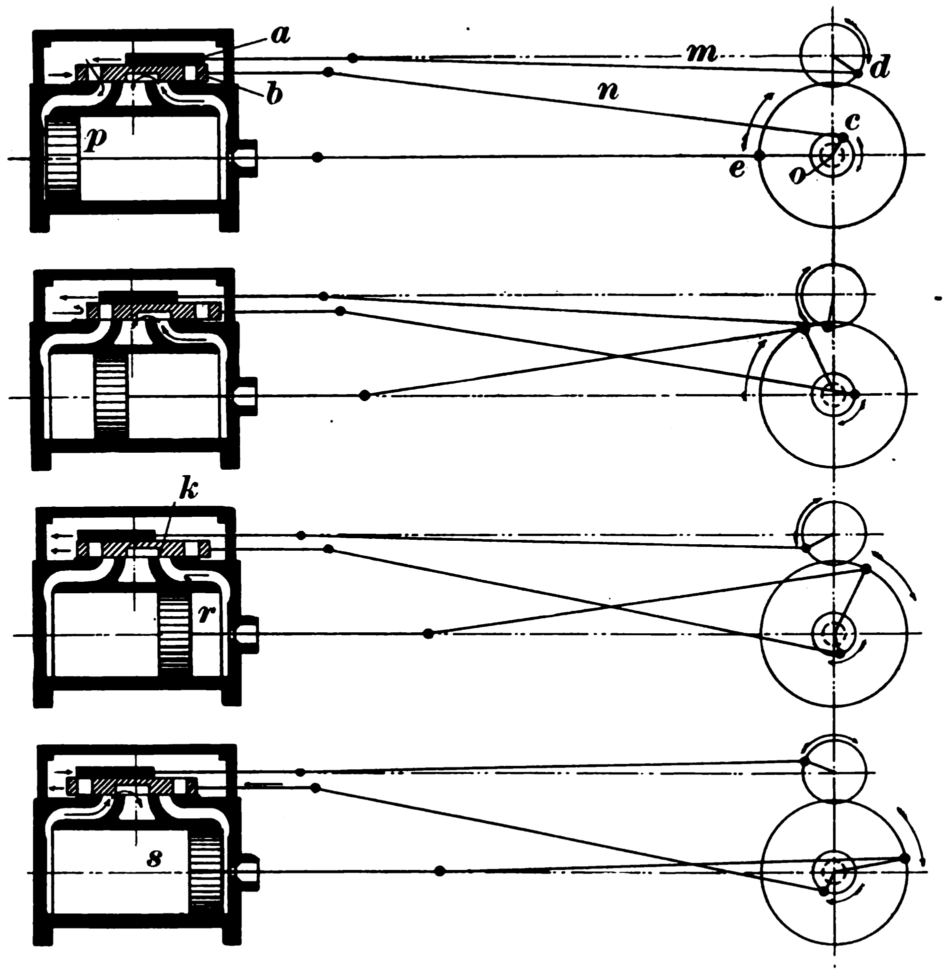
ENGINE VALVES AND VALVE GEARS.

BY C. C. MAJOR.

The Riding Cut-Off.

The single slide-valve is simple in construction and cheap and is used principally on comparatively small engines where an early cut-off is not desired. This form of valve will not give good steam distribution when cut-off is to occur at half stroke or earlier. To secure an early cut-off, the amount of lap must be increased, which decreases the angle through which the eccentric must move to reach its center, thus limiting the movement of the valve when opening the port for the admission of steam. This increase in the angle of advance of the eccentric also interferes with the exhaust functions of the valve, so that some modification of the slide-valve or separate valves controlling the exhaust are used when a high degree of expansion is desired.

One method of securing several expansions is to use two slide-valves which may work in the same or in separate valve chests. The auxiliary valve in this arrangement is known as the "riding cut-off." The main valve is ported and slides upon the valve-seat in a manner similar to the single slide-valve. It is driven by a separate fixed eccentric having a small angular advance, as the steam port is to be closed late in the stroke by this valve. The functions of the main valve are to admit steam to the cylinder, to open the exhaust port, and to produce compression. The duty of the upper valve is to cut off the admission of steam to the ports of the main valve; hence, it is called the "cut-off" or "expansion valve." This valve is operated by an eccentric, the angular advance of which is changed by a governor to control the point of cut-off.



FIGS. 17, 18, 19 AND 20.

Figs. 17, 18, 19 and 20 show the relative positions of the valves, piston, crank and eccentrics of an engine having a riding cut-off valve; *a* is the cut-off or expansion valve, seated on the top of the main valve *b*. The center of the shaft is at *o;* the circle *c* is the path of the center of the eccentric controlling the movement of the main valve *b*, and the circle *d* is the path of the expansion valve eccentric. This latter circle is drawn in the position shown in order that the movement of the expansion valve and the relative position of its eccentric may not be confused with that of the main-valve eccentric.

Fig. 17 shows the crank on the dead center nearest the cylinder and the piston at the head end of the cylinder about to commence its forward stroke. The main-valve has moved far enough to uncover the port to the amount of lead required and the corresponding position of the eccentric is shown by the dot at *c*. As this valve is to close the port late in the stroke, it has only a small amount of lap, consequently, the angular advance of the eccentric is not very great. The expansion-valve eccentric has passed the dead center and the valve is moving to the left, while the main valve is moving to the right as indicated by the arrows.

In Fig. 18, the piston has traveled through one-third its stroke and the main-valve eccentric has reached its dead center, giving the port full opening; but at this point the expansion valve has moved sufficiently to the left to cover the port in the main valve and cut off the steam. The piston will complete its stroke driven by the expansive force in the steam and the energy stored in the flywheel.

Both valves will now move to the left and the next event of the stroke is shown in Fig. 19. The piston has traveled two-thirds of its forward stroke and the exhaust edge *k* of the main valve has closed the port, thus preventing any further escape of the exhaust steam from the space *r* between the piston and the end of the cylinder. The relative positions of the valves and eccentrics are also shown.

In Fig. 20 the piston has nearly reached the end of its stroke, the expansion valve has reached the end of its travel and is returning to the right; while the main valve is just opening the head-end port to exhaust the steam from the space *s* behind the piston.

The advantage of this arrangement of valves over the single slide-valve can be readily seen. Cut-off can be made to occur at any desired point without interfering with the points of compression and release. These two events are changed by giving the main valve a greater or less amount of steam and exhaust lap. As lead is due to the angular advance of the main valve eccentric and this eccentric is fixed to the shaft, the lead is constant. This is also true of the simple slide-valve with its eccentric fixed to the shaft and the engine governed by throttling the steam supply.

Since cut-off occurs when the valves are traveling in opposite directions, the cut-off is quite sharp, thus preventing wire-drawing.

To set the valves of an engine equipped with a riding cut-off, follow the method described in the previous article for the simple slide-valve, setting the main valve first. The crank is placed on dead center, as shown in Fig. 17. The main eccentric is moved around the shaft in the direction in which the engine is to run; or, if there are rocker-arms, move the eccentric to the proper position on the shaft to give the desired lead, and in such a position that the steam port will be opened when the engine turns in the right direction.

After getting the lead, the crank is placed on the opposite center to see if the lead is the same. It should be approximately the same if the connecting-rod has been adjusted to the right length; if it is not the same, the lead must be equalized as previously explained. After the main valve is adjusted, turn the crank over until the piston is in the position desired for cut-off to take place. Turn the expansion valve eccentric on the shaft to cause the valve to move in an opposite direction to that of the main valve until the outside edge of the expansion valve just closes the port of the main valve, as shown in Fig. 19.

The valves of an engine are necessarily set when all the parts are comparatively cool, and, however carefully the work may be done, the steam distribution may be far from perfect when under working conditions, as the metal surrounding the ports, the valves and valve-stems and to a lesser degree the eccentric-rods, are all affected by the heat. The expansion of these various parts may make considerable difference in the adjustment of the valves, and the only true guide is the indicator, which should be used as an aid in making the final adjustment.

A USEFUL DEVICE FOR BAKING ARMATURE COILS.

BY F. B. O'HANLON.

The writer was formerly connected with a station containing a number of Brush open-coil arc light dynamos. From time to time we had armature coils burn out, and found it cheaper and more convenient to rewind these ourselves than to send them back to the makers. Each armature coil contained some 27 pounds of cotton-covered wire, so that it required careful baking out before the machine could be safely put to work at any considerable voltage. As we did not get a large amount of winding to do we could not, of course, afford to install a regular baking oven, and for a considerable time had been in the habit of baking the coils by running the machines slowly on short-circuit through an ammeter, and allowing them to generate a current of about twelve amperes. In order to thoroughly expel all moisture from the coils, it was necessary to continue this baking for at least 50 hours, and as in our case the dynamos were driven in pairs from separate engines, it will readily be seen that this process was a very expensive and inconvenient one. The writer got out an arrangement which overcame these objections and reduced the cost of baking to a nominal one.

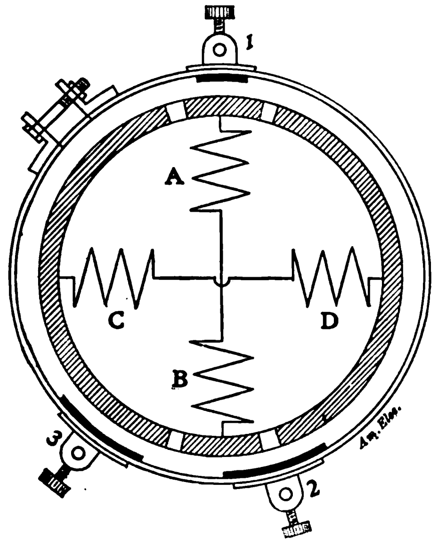


FIG. 1.

A clamp carrying a set of contacts and terminals was fixed to the commutator and a current sent through the coil or coils requiring to be baked. This clamp was made from a piece of ordinary 1-inch leather belting, and the necessary clamping lugs, contacts, and terminals were riveted on as shown in the sketch, which shows the interprojecting segments of a commutator encircled by the clamp. It also shows the arrangement of armature coils which for convenience have been drawn inside the commutator segments; for simplicity only four coils are shown. Diametrically opposite coils are connected in and to diametrically opposite commutator segments; hence by placing the narrow contact, 1, on the narrow interprojecting portion of a segment it is possible by connecting the source of current to terminals 1 and 2, to put coils *A* and *B* in series. Or by connecting from terminal 2 to terminals 1 and 3, the coils are placed in two series of two in parallel.

It will of course be understood that the clamp is made to fit tightly on the commutator instead of as shown in the sketch. It was found that a current of about six amperes was quite enough to bake out a coil when this device was used, although it took about twice as much if the machine was run on short-circuit. This was of course due to the intermittent and varying current density in the latter case, and to the fanning action.

With suitable modifications the device can just as readily be applied to other armatures.

Lessons in Practical Electricity

CAPACITY—THE CONDENSER.

If two sheets of conducting material be arranged parallel to each other a very small distance apart, and then connected to a dynamo or other source of direct current, as indicated by Fig. 1, the plate connected to the positive terminal (+) will receive a positive "charge" of "static" electricity, and a "charge" of opposite polarity will be received by the plate connected to the negative terminal. If now the dynamo be suddenly stopped from supplying its e.m.f., the plates will discharge back through the dynamo and restore the original conditions which existed before they were charged. If, instead of stopping the dynamo from generating, one or both of the connections between it and the plates be broken, and the plates be connected by a piece of wire or other conducting material, as shown in Fig. 2, the plates will "discharge" through the wire. The similarity between this action and the results produced by connecting and disconnecting a magnet to and from a source of current will be evident; in the latter case the applied current sets up magnetic lines of force which induce a momentary e.m.f. when they are allowed to die away by the removal of the exciting current; in the present case, the applied current sets up an electrostatic stress between the two plates which, when released, manifests its existence by a discharge. The property to which this action is due is called "capacity" and sometimes "condensance"; the latter term is derived from the technical name given to the plates, which is "condenser." The unit of capacity is the "farad," so named in honor of Michael Faraday, the great physicist who discovered the phenomenon of electromagnetic induction in 1831. The symbol for capacity is *C*.

The value of the unit of capacity is derived from the relations between the charging current and the e.m.f. produced by it at the terminals of the condenser. If a current averaging one ampere "charges" a condenser to a potential of one volt in one second, that condenser will have a capacity of one farad. Condensers, therefore, have a "time element"; consequently it is not the strength of current alone that determines the charge, but the current strength multiplied by the duration of the charge in seconds. When a steady e.m.f. is first applied to a condenser, the current flow is heavy, but as the potential of the condenser rises the current becomes smaller and smaller, until the potential of the condenser is equal to the applied e.m.f.; then there is no further flow of current, and the condenser is said to be "charged." If the e.m.f. is absolutely steady, the current will decrease at an even rate, and the average current will be one-half of the maximum; if the first rush, for example, were 4 amperes, the average current would be 2 amperes, and if the condenser required 0.1 second to acquire its full charge the quantity of electricity delivered to it would be 0.1 × 2 = 0.2 coulomb. The relations between the applied potential, *E*, the capacity, *C*, of a condenser, and the quantity, *Q*, of electricity delivered to the condenser are as follows:

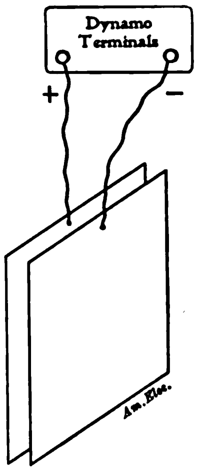


FIG. 1.

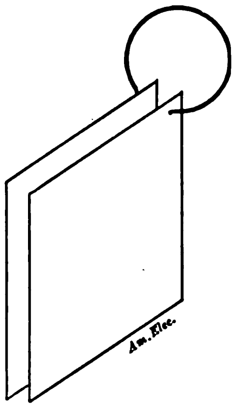


FIG. 2.

$$EC = Q; \qquad \frac{Q}{E} = C; \qquad \frac{Q}{C} = E.$$

The quantity, *Q*, is the product of time and *average* current, as stated previously; the period of charging, however, is extremely short when the charging current is supplied by a dynamo or other source capable of delivering large currents.

If a condenser be connected to a source of alternating current, it will be charged to a potential equal to the ***maximum*** applied e.m.f. during the first quarter of a cycle, discharged during the second quarter, charged again, but in the opposite direction, during the third quarter of the cycle, and discharged during the fourth quarter; this will continue as long as the condenser remains in circuit and the source of alternating current continues to operate. Under these conditions current will flow in the circuit wires just as though the plates of the condenser were all connected together, owing to the rapidly recurring charges and discharges. The relations between applied e.m.f., current, frequency and capacity may be analyzed as follows:

Assuming that the alternating e.m.f. and the current vary according to the sine law (which is always assumed in making computations), the maximum e.m.f. applied to the condenser will be 1.414 times the effective e.m.f. (the value commonly considered, and represented by E). The *average* current strength will be $2/\pi$ times the maximum current strength, and the maximum strength is 1.414 times the effective current strength; consequently, the average current is equal to $2.828/\pi$ times the effective current, I. If the frequency in cycles per second be indicated by f, the time required to charge the condenser to the *maximum* e.m.f. will be $\frac{1}{4} \times 1/f$ second, the charge being imparted in ¼ of a cycle. The quantity, Q, of electricity delivered to the condenser at each charge is equal to the product of the average current, $2.828\ I \div \pi$, and the time, $1 \div 4f$, or

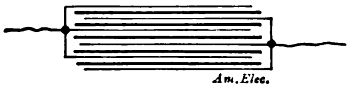


FIG. 3.

$$Q = \frac{2.828\,I}{4\pi f} = \frac{0.707\,I}{\pi f}.$$

Since the maximum e.m.f. $= 1.414\ E$, and also equals $Q \div C$, it follows that

$$1.414\ E = \frac{0.707\,I}{\pi f C},\ \text{so that}\ E = \frac{I}{2\pi f C};$$

therefore,

$$2\pi f C \times E = I,\ \text{and}\ 2\pi f C = \frac{I}{E}.$$

From the last three equations, which are the fundamentals of capacity calculations in alternating-current work, it is evident that capacity is a property in many respects the opposite of inductance. The greater the capacity of a condenser, the more current will pass through it with a given applied e.m.f.; whereas the current that can be passed through an inductive device by a given e.m.f. is *inversely* proportional to the inductance of the device. Moreover, the current passing through a condenser is caused to shift its phase relation with the applied e.m.f. so that it actually *leads* the latter instead of lagging behind it, as in the case of the current in an inductance; the condenser "boosts" the current phase ahead of the e.m.f. while the inductance retards it. If it were possible to pass current through a condenser without encountering any resistance, the current would lead its e.m.f. by exactly one-quarter of a cycle. This will be discussed more fully in the next Lesson.

The capacity of a condenser depends on the area of the facing surfaces of its plates and the specific inductive capacity of the insulating medium which separates the plates, and also upon the proximity of the plates. The specific inductive capacity of the insulating medium is compared with that of air, which is taken at unity. The insulating material between the plates is termed the "dielectric," the reason for which will be obvious upon consideration of the meaning of the word. As the condenser plates are always in intimate contact with the dielectric material between them, the thickness of that material may be taken as the distance between the plates. Representing this by t, the specific inductive capacity of the dielectric by k, and the area of the facing surface of one plate in square inches by A, the capacity of a condenser is given by the formula

$$C = 0.000000000000225\ \frac{A\,k}{t},$$

from which it is evident that with a dielectric only 1/100 inch thick, and a specific inductive capacity as high as 8, a condenser having a capacity of only one farad would have to have a surface of 5,555,555,555 square inches, or 462,929,293 square feet! The unit of one farad is, therefore, too large for practical use, and it is customary to use one-millionth of a farad as the practical unit; this is called the microfarad. The symbol commonly used is the same as that used to denote farads, but it is much better practice to use C for farads and c for microfarads, and this is done by many writers.

In order to obtain an appreciable amount of capacity within a small space, it is customary to make each half of a condenser of several sheets connected together, the sheets of one half intermeshing with those of the other half, with dielectric sheets between, as indicated in Fig. 3, where the thin lines indicate sheets of conducting material and the heavy lines sheets of dielectric material. The sketch shows only the edges of the sheets. Because of this common construction, condensers are always represented in diagrams by the arrangement of lines shown in Fig. 4; this merely represents the conductor plates of the condenser without the dielectric plates. For condensers of the construction indicated by Fig. 3, the capacity formula becomes

$$c = 0.000000225\ \frac{A\,k\,n}{t},$$

n being the number of dielectric sheets; A, the area of one side of each dielectric sheet, in square inches; t, its thickness in inch measure, and k, the specific inductive capacity of the dielectric material. The accompanying table gives the specific inductive capacities of the materials that have been used for dielectrics in condenser construction, the inductivity of air being taken at 1.

Dielectric.	k.
Glass, hard and new	3.11
Glass, hard and old	6.96
Glass, extra dense flint	9.9
Porcelain	4.4
Shellac	2.74
Sulphur	3.
Rubber, pure	2.12
Rubber, hard	2.25
Rubber, vulcanized	2.69
Paraffin	2.
Wax	1.85
Olive oil	3.08
Turpentine	2.25
Sperm oil	3.09
Petroleum, crude	2.07
Petroleum, refined	2.1

A condenser does not necessarily consist of a number of parallel plates, although that is always the commercial form. Any two parallel conductors constitute a condenser if they are insulated from each other, but the capacity of two ordinary wires situated parallel to each other is very small unless their length is enormous. If a piece of tinfoil be wrapped about an incandescent lamp bulb, the lamp will become a condenser, the foil being one electrode and the filament the other. Similarly, electrical conductors made up into the form of an insulated cable, with an outer sheath of lead, form a condenser, the central conductors being one electrode and the lead sheath the other.

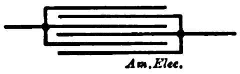


FIG. 4.

[Note.—In the Lessons department last month the equation on page 161, giving equivalents of alternating-current conductance G, included the expression $Z \cos \phi$; this was a typographical error and should have read $K \cot \phi$. $Z \cos \phi$ is equal to the resistance, not the conductance, of the circuit.]

Letters on Practical Subjects

The Underwriters' Rules and Inspection.

To the Editor, American Electrician:—

In a communication printed in your January number, Mr. Roy C. Jackson takes the Underwriters to task because they have failed to provide rules governing the erection and maintenance of buildings in more respects than the manner in which electric wiring shall be installed and used. Mr. Jackson finds all his ground for complaint in the carelessness with which the other parts of a building are constructed, and in the fact that the electrical inspector usually camps closely on the trail of the electrician So far as my experience goes, I have yet to see a branch of the building trades that produces more careless mechanics than are found among electrical workers. By a system of instruction and examination the Brotherhood of Electrical Workers is attempting to rid the fraternity of the "jerry" wireman, but the efforts in this direction are scarcely begun, and it will probably be necessary for several years yet for the ubiquitous inspector to "camp upon our trail."

Referring to other things about buildings in which there seems to be almost criminal carelessness, I think that upon investigation Mr. Jackson will find that nearly every town of any size attempts to regulate the construction of public buildings, although it must be admitted that the intentions of the people in such matters are more often disregarded than faithfully carried out. This is, however, the fault of the officials appointed to do the work. Probably in most cases, municipal inspectors are appointed through political influence and discharge their functions according to political lights rather than conscientious motives; it is beyond question that the depth of American worthlessness is reached in the breed of petty politicians peculiar to this country. Mr. Jackson will find that we have about all the rules and regulations required if we only had officials appointed on merit and imbued with a determination to see justice done to all concerned. Let us, the electrical workers, strive always to work conscientiously and keep in mind perpetually the moral obligation to safeguard human life and property; then the inspector may camp upon our trail to his heart's content.

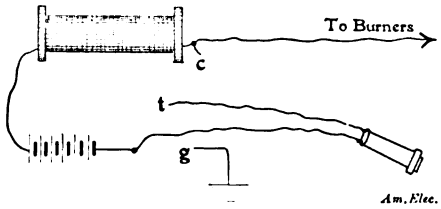
Houghton, Mich. GEO. S. CRABBE.

A Simple Method of Testing Gas Lighting and Electric Bell Circuits.

To the Editor, American Electrician:

Thinking that some of your readers might be interested to know of a simple but good method of testing gas lighting, electric bell and similar circuits for leakage, I submit the accompanying diagram and the following explanation. The diagram here shown is intended to apply to gas lighting circuits. One terminal of a sensitive telephone receiver is connected to the terminal of the battery which is usually grounded, the ground connection being temporarily broken. The other terminal, *t*, of the receiver is then applied to the burner circuit where it leaves the spark coil at *c*, being put in contact with and removed from the wire several times in order to note clearly the strength of the click caused in the receiver. Then the free terminal *t* is touched repeatedly to the ground connection or a gas pipe. If there is any leakage a click will be heard, and a comparison of the sounds obtained in the last test with those obtained when the telephone is connected to the spark coil terminal will give a good indication of the extent of the leakage. If no click is heard when the receiver is connected to the ground and the battery, the circuit is clear, assuming, of course, that the wires from the spark coil to the burners are all sound.

It is well known that a small leakage will weaken the batteries in a short time, even though the leaking current may not be sufficiently strong to be detected in the ordinary way without the use of expensive instruments.



CONNECTIONS FOR TESTING GAS LIGHTING AND CALL BELL CIRCUITS.

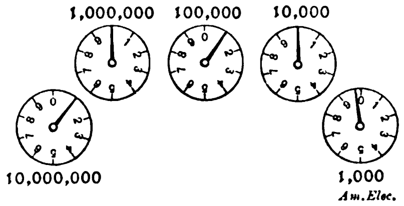
The same method may be applied to electric bell circuits; in this case there is no spark coil, of course, so that the terminal *t* is touched to the circuit terminal of the batteries in the first part of the test and to the ground or common-return wire in the second. The receiver can also be used to tell whether or not a bell rings when a button is pushed by connecting the receiver terminals to the contacts of the push-button and pressing the button two or three times; if a buzzing noise is heard in the receiver after the connection between the push-button contact is broken, the bell rings. If the bell fails to ring, the receiver will merely give a single click, and if the circuit is broken between the button and the bell no noise will be heard in the receiver.

Brookline, Mass. E. S. LINCOLN.

Mr. Ryder's Meter Reading.

To the Editor, American Electrician:

Referring to Mr. Ralph Ryder's tricky meter reading published in the March number, I should say that the meter reads 1,009,900, and submit the following explanation of this result: It is plain that the first dial reads between 900 and 1000, since the hand has not quite reached zero; the reading here, therefore, would be taken as 900. The second dial, though apparently indicating zero, must be taken to read 9 until the hand on the first dial has completed its revolution; so that these two dials indicate 9900. The third dial is a little misleading, the pointer being exactly over the 1, but this dial cannot read 1 until the second dial indicates zero, and the first dial proves that this is not the case. Since the third dial is well started on its revolution, the fourth dial will read zero as it indicates, in which case the fifth dial must read 1. If the pointer of the first dial had been actually at zero, then the reading of all the other dials would have been exactly as they appear to indicate.



A TRICKY METER READING.

New York. LEWIS C. REYNOLDS.

[NOTE.—The same result and reasoning have been sent in by C. J. Abbey, Skowhegan, Me.; A. B. Case, Chicago, Ill.; H. Lee Clark, Canton, Pa.; C. C. Daugherty, Princeton, Ind., and Charles M. Green, Conneaut, Ohio.

The same result, without the detailed explanation of its derivation, was sent in by J. R. Adams, River Fall, Wis.; Walter Beck, Doylestown, Pa.; Ralph L. Britain, Richmond, Vt.; Ervin J. Casper, Vallejo, Cal.; Frederick L. Crass, Hartford, Conn.; Linwood Cushman, Bar Harbor, Me.; E. E. Devendorf, Amsterdam, N. Y.; S. C. Ensor, Mt. Washington, Md.; Thomas M. Gibbes, Atlanta, Ga.; Geo. A. Gould, Phillipsdale, R. I.; William G. Hurtzig, Morristown, N. J.; E. R. Horseley, Goldfield, Colo.; Henry D. Jackson, Boston, Mass.; Percy M. Jones, Paterson, N. J.; V. H. Julian, Ridgefarm, Ill.; E. Keenan, Auburn, N. Y.; Burton E. Lucas, Ovid, Mich.; F. J. Meyer, Oklahoma, O. T.; C. C. Michael, Bristol, Conn.; Robert Montgomery, Jeffersonville, Ind.; H. Notthoff, Santa Monica, Cal.; Nutting & Goodwin, Litchfield, Conn.; D. S. Overdorff, Johnstown, Pa.; Allan W. Pattee, Monmouth, Ill.; John G. Peebles, Nashville, Ill.; E. S. Rockafeller, Monticello, N. Y.; W. S. Stratton, New York; J. C. Sweeney, Lima, Ohio; F. H. Tice, Baltimore, Md.; George Veidt, St. Louis, Mo.; J. A. Ward, Sturgis, So. Dak.; A. S. Weibel, Allentown, Pa.; J. G. Whittemore, Benson, Minn.; Samuel Wilkinson, Northville, Mich.; Herbert Williams, Charlotte, Mich.; L. F. Woodhead, Union City, Tenn.; F. H. Woodhull, Coatesville, Pa., and C. F. Zachau, Arlington, N. J. —EDITOR.]

To the Editor, American Electrician:

The meter dials shown by Mr. Ryder in the March issue are somewhat of a puzzle until it is remembered that the position of each pointer on its dial is determined not alone by an inspection of the pointer itself but by knowing the position of the pointer preceding it. The extreme right-hand dial reads 975; the next dial appears to be at zero, but as the pointer on the first dial has not completed its revolution that on the second dial cannot have reached zero, so that the latter still indicates 9. The third dial is still in the zero space because it cannot have reached 1 until the pointer of the second dial has completed its revolution. The pointer of the fourth dial has passed its zero for the reason that the pointer of the third dial has completed a revolution and is on its way to the 1 mark. The pointter on the last dial obviously indicates 1, as the pointer on the dial preceding it has passed zero. The total reading, therefore, is 1,009,975.

Jordan, Minn. S. L. SLY.

[NOTE.—Similar solutions to that of Mr. Sly have been furnished by Joel Gomborow, Lynn, Mass., and J. G. Hackley, New York, the only difference being that these two readers estimate the position of the right-hand pointer to be at 980 instead of 975. The difference is, of course, negligible, and the correct reading may be taken as 1,009,975, 1,009,980 or 1,009,900. In some stations it is the practice to read the position of the right-hand pointer down to a half division, but not closer. Under this rule the reading would be 1,009,950, as the right-hand pointer has passed the half-way point between 9 and 0.

The second and fourth dials in the diagram should be numbered in the counter clockwise direction instead of clockwise; the error in numbering was due to our engraver, who evidently supposed all of the dials should be numbered in the same direction. The error, however, does not affect the result, as the pointers of both of these dials are in line with the zero mark.—EDITOR.]

Voltage Disturbance in Parallel Operation.

To the Editor, American Electrician:—

I have in my care four 110-volt generators operating in multiple; their capacities are as follows: Two of 75-kw. each, driven by one engine, one of 100-kw. driven by another engine, one of 200-kw. driven by a third engine; the engines are in no way connected together.

While running the generators all take their proper load when regulated by their different rheostats, but the trouble is that throwing one in or out of circuit with the other changes the voltage of the circuit and therefore the speed of the motors. This change of speed is only for about 15 seconds, but in that time the speed of the motors changes and in turn the machinery is effected, and the material manufactured by it is injured by the change.

If we only use lights instead of power it would make no difference for that short time, but as it is the machinery must run at a steady speed at all times. Kindly ask some of your readers to suggest a remedy for the trouble. Is there any voltage regulator or anything that will keep the voltage absolutely constant at all times?

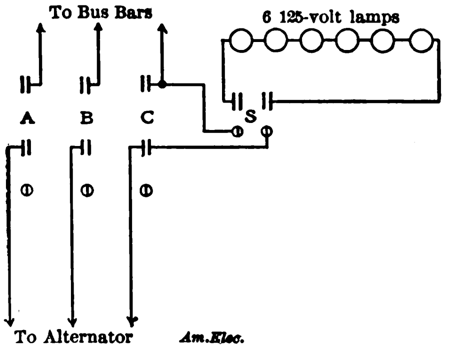
Union Hill, N. J. ERNEST F. HARTWELL.

◆◆◆

Mr. Bailey's Synchronizing Voltage.

To the Editor, American Electrician:

In answer to Mr. E. W. Bailey's question in the March issue regarding the voltage across his synchronizing lamps, I should like to point out that when the machines are in synchronism the voltage across the lamps is, of course, zero, the two voltages being equal and opposed when the lamps are dark. When the machines are out of step, however, the voltage depends upon the amount of variation; and when the phases are exactly opposed, or 180 deg. apart, the voltage across the synchronizing lamps is equal to the sum of the voltages of the two machines. The reason that the voltmeter never indicates this value is because the period during which this condition exists is so short that the instrument does not have a chance to indicate it. If Mr. Bailey will try to get his machines in step with the lamps bright and then read the voltage, he will notice that this is true.



CONNECTIONS FOR SYNCHRONIZING.

Boston, Mass. HENRY D. JACKSON.

[NOTE.—The same explanation has been submitted by A. B. Case, Chicago, Ill., and Henry Mulford, Patchogue, L. I., except as to the reason why the voltmeter never indicates more than 720.—EDITOR.]

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Adjusting the Compounding of a Dynamo.

To the Editor, American Electrician:—

In your February number "D. R. P." asked for "two ways to adjust the compoundinng of a direct current dynamo." When a machine is over compounded is it not well to increase the flow of current in the shunt coils and reduce the speed of the machine (provided, of course, the wire will permit) so as to diminish the flow in the series? Or if under compounded, diminish the flow in the shunt by introducing more resistance and increasing the speed? For instance, I have a ten-pole machine very much over-compounded. I separate the shunt field magnet winding into two groups of five coils each and connected the two halves of the shunt field in parallel. I could then reduce the speed about 15 revolutions per minute and the machine balanced perfectly. The reduction in speed was desirable in this as the machine worked most of the time on about one-half load. The coils did not heat perceptibly but the rheostat showed some distress, but not more than I have seen some others connected in the ordinary way.

From the way the question was asked, I have no doubt "D. R. P." had something of this kind in his mind. A case of under compounding came "up to me" some years ago aboard ship. I had two small by-polar machines which were rated at 360 r.p.m., but with the resistance of the rheostat all cut out the voltage would go down at full load. I began increasing the speed and cutting in resistance until I reached 390 r.p.m. and had all the field resistance cut in, under which conditions the voltage would come up with just the pilot lamps on, and remain the same to full load. I never found it necessary to change the position of the rheostat as long as I remained in charge. I might add that previous to my time, the shunt field coils got very hot, in fact, they burned out on both machines. Of course, we know these are the results of miscalcultaions in building, but what is the engineer to do is often what we have to determine.

Washington, D. C. LEWIS JONES.

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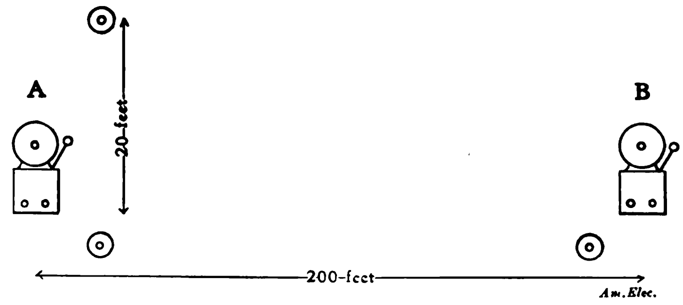
Another Problem in Bell Connections.

To the Editor, American Electrician:

The accompanying diagram indicates two ordinary electric vibrating bells and three push-buttons, two of the push-buttons and one bell being located at Station *A* and the other push-button and bell at the other station, *B*. The distances between the two bells and the bell and upper push-button at Station *A* are marked on the diagram. Each of the two push-buttons at Station *A* must be connected so that the bell at Station *B* may be rung by depressing either of them. The push-button at Station *B*, of course, is connected to ring the bell at Station *A*. The problem is to make the connections with the most economical use of wire. I should like very much to have this little problem submitted to readers of the AMERICAN ELECTRICIAN.



PROBLEM IN BELL CONNECTIONS.

St. Louis, Mo. FRED D. MAHAFFEY.

[NOTE.—Solutions of the above problem, in order to be published in the May number of the paper, must reach this office not later than April 16. Readers who would like to submit solutions but prefer not to have them published may do so with the assurance that their communications will receive the same attention as those intended for publication. —EDITOR.]

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The New Double-Commutator Motor.

To the Editor, American Electrician:—

In your March issue, containing a description of the new variable speed motor, of the Commercial Electric Company, I beg to call your attention to an error in your description of the method of winding the armatures and the method of control used in these machines. It is stated in your description that the motors "have two armature windings exactly alike, connected to commutators at both ends of the armature" and that the control is effected by connecting these two armature windings in series, or in parallel, according to the speed required. As a matter of fact, the windings connected to the two commutators are *not alike*, but are of the same size wire having different numbers of turns, which are usually in the ratio of three turns on one end to two turns on the other end, and in this feature lies the distinct difference between the "Commercial" motor and the ordinary two-commutator motor which has been in use for some time, the change enabling us to secure three, or even four, fundamental speeds with a given field strength, by properly combining these armature windings,, instead of two which are all that can be obtained when the simple series-parallel system of control is used.

To obtain the various speeds, these windings are connected to a supply circuit of constant voltage singly, or in series cumulatively, or in series differentially; as the windings are of the same ampere capacity, the maximum current input to the motor is the same whatever combination is used; and as the efficiency is practically constant a constant brake horse-power is developed at all speeds, instead of a horse-power varying with the speed, as is obtained by the series parallel system. This system of connection also has the result that the maximum ampere-turns of the armature are inversely proportional to the speed, so that the torque exerted by the armature is the greatest at the slowest speed, and lightest at the highest speed, which is exactly the condition required to secure the maximum output from any machine tool, such as a lathe, or boring mill, in which the maximum depth of cut and maximum feed are desired at a constant cutting speed, whatever the diameters may be.

M. O. SOUTHWORTH,
Engineer, Commercial Electric Company.
Indianapolis, Ind.

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

Where can castings be obtained for the gas engine described in the January number of the AMERICAN ELECTRICIAN? L. I. L.

From Parsell & Weed, 129 West 31st Street, New York City.

In the December number of the AMERICAN ELECTRICIAN, the description of an ammeter on page 601 calls for a phosphor-bronze spring No. 30x40 (in the second column, the second line, beneath Fig. 7). What do the figures 30x40 mean? C. A. B.

B. & S. gauge numbers. Mr. Brocksmith writes, however, that the spring may perferably be made 0.005 × 0.2 inch.

If the charge in a gas engine cylinder were exploded with the moving parts all blocked, and the cylinder remained air-tight and undamaged, would the pressure due to the explosion remain at the same point as at the instant of explosion? E. C. B.

No. The pressure would fall slowly as the temperature of the gases within the cylinder became lower due to the conduction of heat through the cylinder walls to surrounding air.

What size of wire should be used to wind a medical coil having a core 7/16 inch in diameter and 3¼ inches long? (2) Will double cotton insulation be suitable? (3) Why are the contact screws on induction coil vibrators tipped with platinum? U. D.

No. 24 B. & S. gauge, making the coil three inches long parallel with the core and ½ inch deep. (2) No; double silk-covered wire should be used. (3) In order to prevent sparking from damaging the contact points.

Why are split spools used for magnet coils? (2) Under which conditions will dry batteries last longer, when supplying 1½ amperes for a quarter of a second at five-minute intervals, or when supplying 3 amperes for a quarter of a second at ten-minute intervals? N. J.

In order to prevent the metal spool from acting as a closed secondary with relation to the winding of the magnet; they are usually unnecessary except for alternating-current magnets. (2) The batteries would last longer giving 1½ amperes every five minutes.

What is the best method of installing 110-volt direct-current incandescent lighting circuits in a very steamy place? (2) How can I make a direct-current ceiling fan motor run 25 per cent faster than it now does? A. R. T.

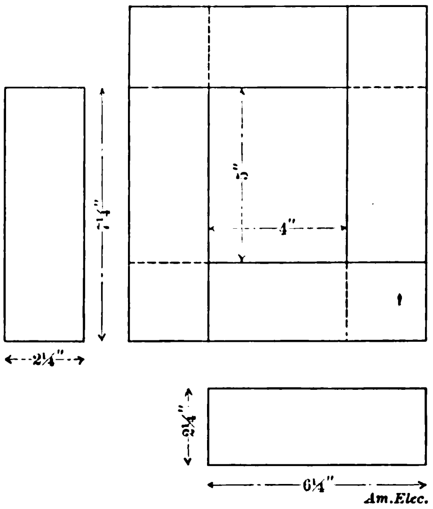
Run the wires in insulated iron conduit and do not use any pendants. Use weather-proof sockets attached to galvanized iron pipe and cover the joints between the sockets and the pipes with rubber tape. (2) You may be able to obtain this result by connecting a resistance coil in parallel with the field-magnet winding. You will have to determine by experiment the amount of resistance necessary.

When two compound-wound dynamos are operated on a three-wire system, would there be any advantage in exciting the shunt field windings of both machines from one of them? (2) Should the series fields be connected by an equalizer as in the case of parallel operation? G. A. V.

No; this would be rather a disadvantage than otherwise, since both machines would be useless if the one to which the shunt winding were connected should become disabled. (2) Certainly not; the machines are practically in series and connecting them by a low-resistance conductor would have the effect of short-circuiting one-half of the three-wire system, and one of the dynamos.

Can you give me the necessary data for the construction of a transformer having a 110-volt primary and a 5-volt secondary, the secondary current to be 200 amperes and the frequency of the supply current 60 cycles? W. A. T.

Make the core of annealed sheet steel strips 2¼ inches wide and 25 mils thick, putting 75 strips in each leg and each cross-bar of the core. The lengths of the strips must be such that the core when built up will have the dimensions shown in the accompanying sketch. Use No. 9 double cotton-covered magnet wire for the primary winding, putting 5 layers on each leg of the core and 35 turns in each layer, so as to obtain 350 turns total. Make the secondary winding of strip copper 3-16 inch thick by 2⅛ inches wide. Put 8 turns on each leg of the core and divide the winding on each leg into two sections, side by side, of four turns each, and connect the two inner ends of these sections in order to avoid leading a terminal out from the inside. The two sections must, of course, be wound in opposite directions from the joint between their inner terminals. Apply a strip of shellacked linen to the inner surface of the copper strip before winding it in place.



What is the formula for the flow of gas through a pipe of given diameter and length with a given drop in pressure? C. W. K.

Representing the quantity of gas in cubic feet per hour by Q, the diameter of the pipe in inches by d, the drop in pressure in pounds by p, the specific gravity of the gas by s, and the length of the pipe in feet by L, the formula is

$$Q = \sqrt{\frac{d^5\, 830p}{s\,L}}$$

The value of s is the ratio of the weight of gas per cubic foot to the weight of air per cubic foot at a given temperature.

How can permanent magnets be made of cast iron? (2) What size of wire and how much will be required to make a set of resistance coils from 0.01 to 1 ohm in steps of 0.01 ohm and from 1 to 10 ohms in steps of 1 ohm? (3) How many volts are required to jump across one inch of dry air when a static machine or large induction coil is used? H. H. T.

Permanent magnets cannot be made of cast iron; the very best grade of either tungsten or chrome steel is required. (2) The size of wire depends upon the strength of current your resistances are expected to stand. Either German silver or platinoid wire should be used, and the quantity cannot be calculated without knowing the exact quality of the wire. (3) About 20,000 volts.

A bipolar shunt-wound motor built for 500 volts was changed to run at 110 volts by connecting the armature coils in groups of four in parallel, each group of four being considered a single coil. The correct speed was obtained, but the motor took an abnormal current at no load and heated badly. It tested clear of grounds and short-circuits and held its speed under load. What was the probable cause of the excessive no-load current and overheating? (2) Can a two-path armature wound to operate at 500 volts in a four-pole field-magnet be changed to run on 110 volts by putting two coils in parallel, connecting the winding lap fashion, and putting on four sets of brushes? G. E. M.

Some of the armature coils were probably connected up wrong so as to form closed circuits in the winding. If all the coils in each group of four were not precisely alike, this would account for part of the trouble mentioned. (2) Yes, provided one coil be omitted and dead-ended so as to leave an even number of coils. Two of the commutator segments would have to be bridged together into one.

If one has a formula such as $m = \frac{a\ b\ c}{x\ y}$, what is the rule for finding the value of one of the other letters when m is known? (2) Is the end of a compass needle which points north actually the north pole of the needle? (3) Does excessive pressure of a brush on the commutator of a dynamo or motor produce green or red sparks at the brush tips? G. A. J.

Your equation can be transposed to read $m\ x\ y = a\ b\ c$, and this can be further transposed by putting any two factors in one member of the equation underneath the three factors of the other member, according to which one of the six factors is unknown. For example $x = \frac{a\ b\ c}{m\ y}$; $a = \frac{m\ x\ y}{b\ c}$; $c = \frac{m\ x\ y}{a\ b}$. You will find in any good school algebra a full exposition of all kinds of equations. (2) The end which points north is the north pole according to the accepted magnetic nomenclature and corresponds to that pole of a dynamo field-magnet which is ordinarily termed the north pole. As a matter of fact, however, these poles are of the same magnetic sign as the south pole of the earth. (3) Not unless the sparks previously existed beneath the brush, or unless the pressure is so great as to grind off small particles of copper from the brushes and commutator segments.

POWER PLANT OF THE NEW ENGLAND CONFECTIONERY COMPANY, BOSTON, MASS.

One of the greatest difficulties that confronts the engineer when designing a power plant to serve a factory, located within the limits of a large city where land is expensive, is the placing of the apparatus in the smallest possible space without overcrowding it. This problem has been masterfully handled in the New England Confectionery Company's works, in Boston, Mass., as reference to the illustrations will show. The buildings are located on the South Boston side of Fort Point Channel, and cover a ground area of about 40,000 square feet. The demand of this plant for power is not a small one. For general power purposes about 40 Crocker-Wheeler motors aggregating 365 horse-power are used, mostly for group driving by belt and shafting. In addition there are five elevators direct-driven by Holtzer-Cabot motors and five Sturtevant fans for ventilating, driven by direct-connected motors of the same make, the ten outfits representing a combined total of 110 horse-power. Two ¼-h.p. motors for a pneumatic tube system and some fifteen desk fans complete the list of the power consumers. For lighting, the building is provided with about 1300 16-c.p. incandescent lamps and three arc lamps. It is quite remarkable that all of the apparatus, including the boiler equipment, engine-generator equipment, refrigerating outfit and pumps for boiler feeding, condensing, house service, returns from heating system, etc., are contained in a section of the basement 6038 square feet in area, or but 15 per cent of the total ground area occupied.

The boiler-room contains 3530 square feet; this includes a storage space for about 200 tons of coal and allows for the future installation of double the present equipment of boilers. The three now in place are of the return tubular pattern built by Edward Kendall & Sons, Cambridgeport, Mass., and generate steam at a pressure of 145 pounds. Each is 78 inches in diameter by 18 feet long, and has a total heating surface of 2376 square feet, and a grate surface of 49 square feet. A 10-inch gauge, a 5-inch safety valve and a Reliance water column is provided for each boiler. The smoke outlets connect to a breeching 4 x 6½ feet in cross section, which contains a Mason damper regulator and leads to the base of a stack 6 feet in internal diameter and 125 feet high. The steam outlets, each 6 inches in diameter, connect through Wainwright corrugated expansion joints to a 12-inch header at the rear of the boilers, in which provision has been left for the connection of the three additional boilers, as it becomes necessary to erect them.

The live-steam main for the engines is taken off near one end of the 12-inch header and contains a Locke emergency automatic safety shut-off valve and an 8-inch Cochrane steam separator. From the other end of the header through another Locke shut-off valve a 10-inch connection is made to a short auxiliary header in the engine-room which supplies the various pumps, and through a 6-inch Watts regulating valve, reducing to 90 pounds, connects to a riser which conveys about the building the steam used at this intermediate pressure for manufacturing purposes. Through another Watts reducing valve from the auxiliary header a 15-pound pressure is obtained for manufacturing use and the heating system, when the exhaust from the various pumps and the small non-condensing engine is not sufficient. On the low pressure side each

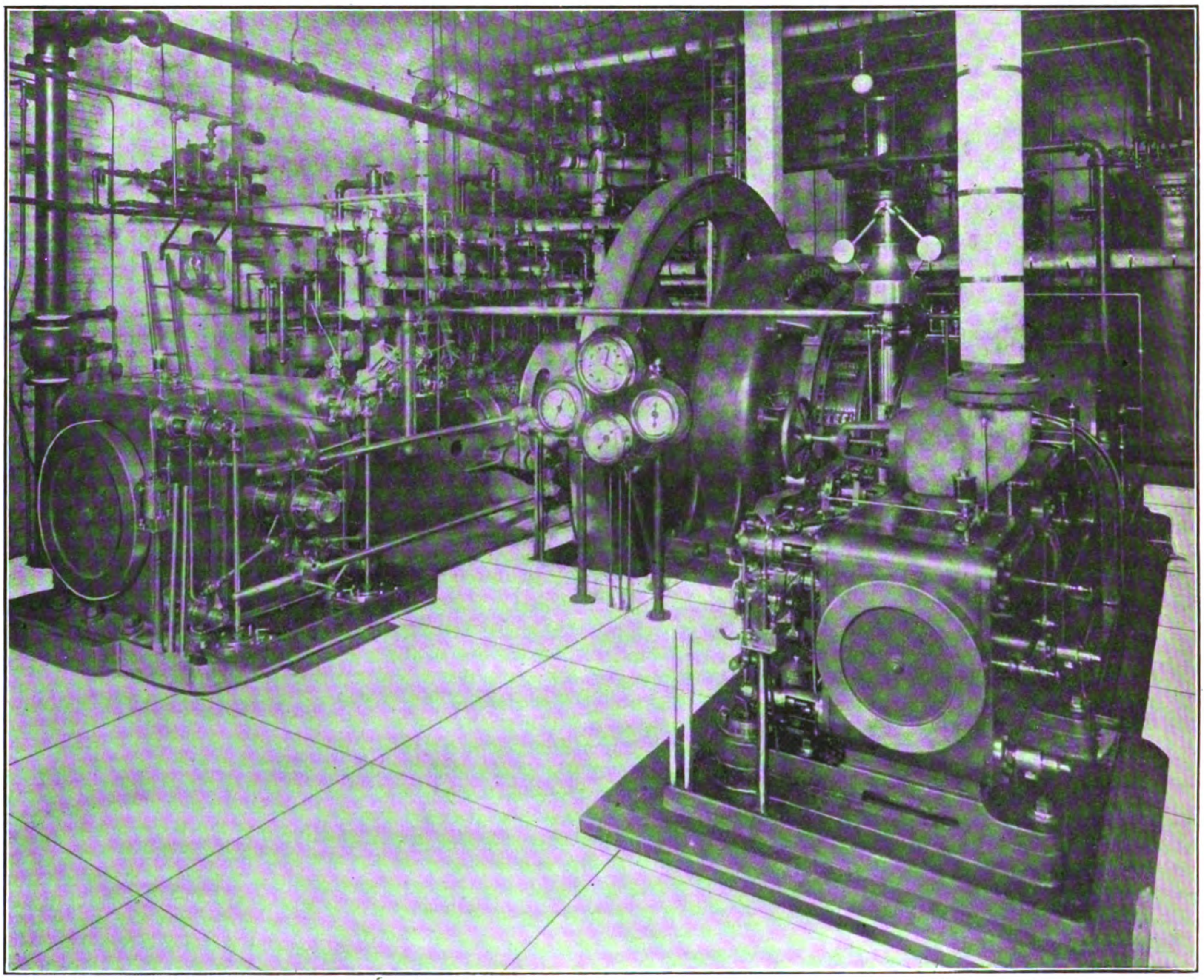


FIG. I.—VIEW OF ENGINE ROOM SHOWING MAIN GENERATING UNIT.

reducing valve has a Crosby inspector safety valve, the first set to blow off at 100 and the other at 25 pounds. Steam piping is of wrought steel with Van Stone flange joints for 5-inch and above, and the sizes below are wrought iron with flanges screwed on.

The engine-generator equipment includes two direct-connected sets, delivering direct-current at 230 volts. The larger one, used during working hours, consists of a 12-pole Crocker-Wheeler generator of 370 kilowatts capacity, driven at 120 revolutions per minute, by a 16 and 32 x 36-inch Corliss-type compound engine, built by the Filer & Stowell Company, of Milwaukee, Wis. During the lunch hour this set is stopped and a smaller set, having a capacity of 50 kilowatts, often used for night loads also, is run instead. The dynamo is a 6-pole Crocker-Wheeler machine and is driven at 275 revolutions per minute by an 11 x 12-inch simple horizontal Ames Iron Works engine. This set is run noncondensing and exhausts into the low-pressure system through a 5-inch Lowden oil extractor. The compound engine exhausts to a Knowles 9 x 18 x 12-inch vertical twin air pump and jet condenser, which maintains a vacuum of about 26 inches. Between the high and low pressure cylinders there is a gauge board containing a clock, a gauge for the initial steam pressure, one for the pressure at which the steam is exhausted from the first to the second cylinder, and one for the vacuum in the condenser. In addition to the ordinary oil cups which are used only in case of emergency, all bearings and rubbing parts are lubricated through a gravity oiling system from an elevated reservoir, having a capacity of 60 gallons. After being used the oil is passed through two 2-gallon White Star filters made by the Pittsburg Gauge and Supply Company, and is returned to the storage tank by a 2½ x 1¼ x 3-inch Warren pump.

From the generators to the switchboard the feeders are taken in conduits under the floor. The switchboard is an exceedingly simple one and handily located near both generators and away from the wall so that all parts are accessible. It is 78 inches wide by 84 inches high, and was built by the Albert and J. M. Anderson Manufacturing Company, of Boston, Mass. The equipment is clearly shown in Fig. 3 and is as follows (reading from left to right and from top to bottom): a voltmeter with a 250-volt scale; a 2000-ampere ammeter for the large generator; a 300-ampere ammeter for the small generator; a double-pole single-throw switch for the engine and boiler-room lights; four similar switches for the

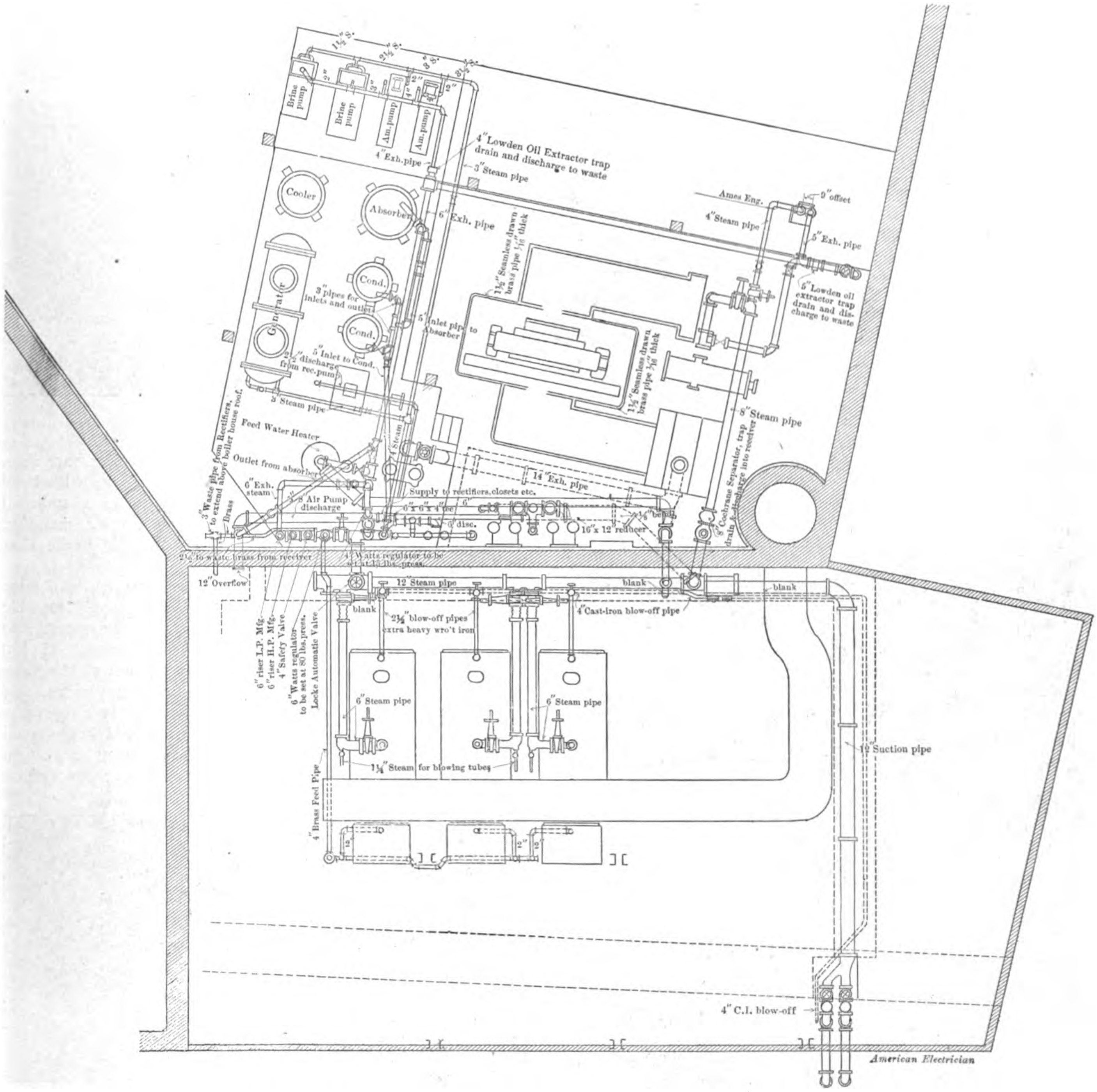

1½" S.
2½" S.
3" S.
3½" S.
2"
3"
4"
12"
Brine pump
Brine pump
Am. pump
Am. pump
4" Exh. pipe
4" Lowden Oil Extractor trap drain and discharge to waste
3" Steam pipe
Cooler
Absorber
6" Exh. pipe
1½" Seamless drawn brass pipe 1/16" thick
Generator
Cond.
Cond.
3" pipes for inlets and outlets
5" Inlet pipe to Absorber
5" Inlet to Cond.
2½" discharge from rec. pump
3" Steam pipe
Feed Water Heater
Outlet from absorber
4" Steam
6" Exh. steam
3" Waste pipe from Rectifiers, to extend above boiler house roof.
Brass
8" Air Pump discharge
Supply to rectifiers, closets etc.
6"
6" x 6" x 4" tee
6" disc.
14" Exh. pipe
16" x 12" reducer
1⅛" bend
Ames Eng.
9" offset
4" Steam pipe
5" Exh. pipe
5" Lowden oil extractor trap drain and discharge to waste
8" Steam pipe
8" Cochrane Separator, trap drain & discharge into receiver
2½" to waste brass from receiver
4" Watts regulator to be set at 15 lbs. press.
12" Overflow
12" Steam pipe
blank
blank
blank
4" Cast-iron blow-off pipe
2½" blow-off pipes extra heavy wro't iron
6" riser L.P. Mfg.
6" riser H.P. Mfg.
4" Safety Valve
6" Watts regulator to be set at 80 lbs. press.
Locke Automatic Valve
6" Steam pipe
6" Steam pipe
1¼" Steam for blowing tubes
4" Brass Feed Pipe
12" Suction pipe
4" C.I. blow-off
American Electrician

FIG. 2.—PLAN VIEW OF THE NEW ENGLAND CONFECTIONERY COMPANY'S POWER PLANT.

lighting in the first, second, third and fourth buildings; a plug switch for connecting the voltmeter with either generator; a ground-detector lamp for each machine; a field rheostat for the large machine; three double-pole, single-throw switches for power in the first, second and third buildings; a rheostat for the small machine; a double-pole single-throw switch controlling the feeders to the elevators; a double-pole double-throw switch for connecting the bus bars to either generator, and a double-pole single-throw switch for the power in the fourth building.

The pumps for the most part are placed vertically along or close to the walls, and it is in this way that the great saving of floor space in the engine-room is effected. Inasmuch as the plant is located on the shore of the Fort Point Channel, an inlet from Boston harbor, salt water is available in large quantities and at no expense. It was endeavored to take advantage of this condition of affairs by utilizing salt water for condensing purposes and for use in toilet fixtures, the city supply of fresh water being drawn upon only for the boiler feed, manufacturing service and drinking water. The salt-water supply is taken through two 8-inch pipes leading from the harbor, each having a removable Blake copper wire strainer. These combine into a 14-inch pipe which passes along a trench into the engine-room, where it enlarges to 16 inches and connects to the suction ends of two Warren steam pumps, the compound-engine condenser and the ammonia condensers. The discharge from the condensers passes into a waste elbow through the wall between the engine and boiler-rooms to the east end of the latter and returns to the channel. All the salt-water piping is of cast iron, extra strong, coated inside and out with tar and made up with flanges. The salt water pumps which supply the circulating water for the refrigerating system and that used for sanitary purposes have cylinders 14 x 9 x 12 inches, and are cross-connected so that they may be used interchangeably.

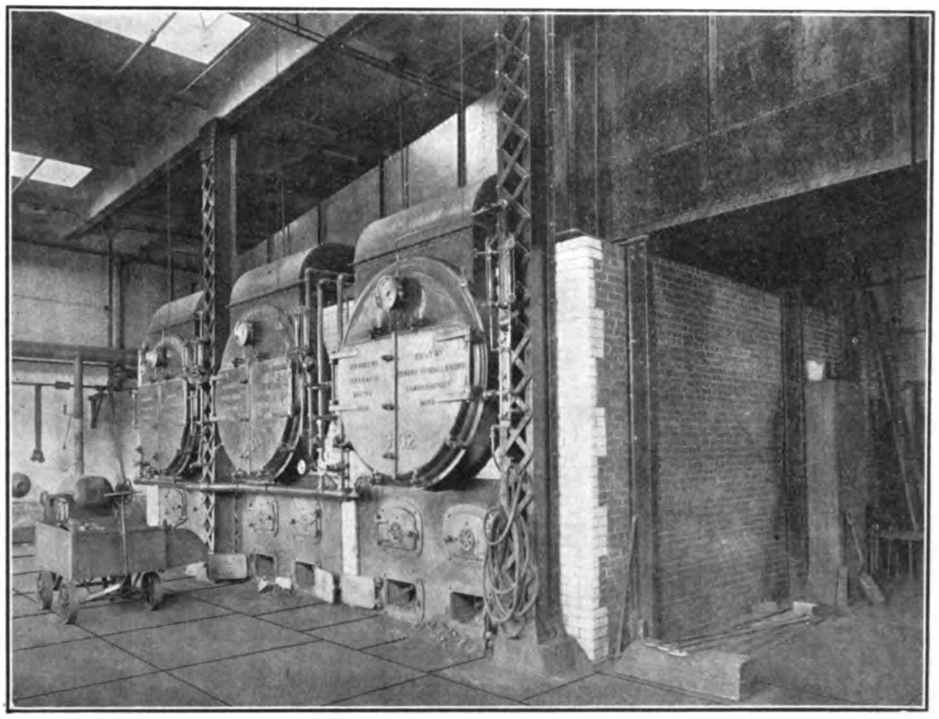


FIG. 4.—BOILER ROOM.

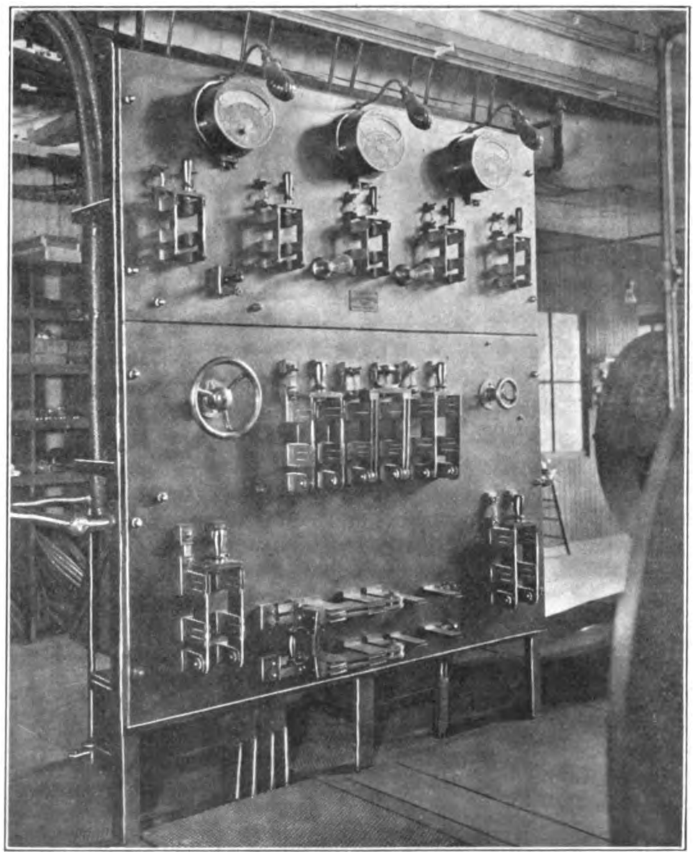


FIG. 3.—SWITCHBOARD.

The fresh-water supply is taken from the main through a 3-inch connection which immediately enlarges to 6 inches and finally to 8 inches near the pumps. For boiler feeding there are two vertical cross-connected 8 x 5 x 12-inch Warren pumps. Another vertical pump of the same make with cylinders 7½ x 4 x 10 inches is for house-service, and discharges through air chambers which provide the pressure necessary to distribute it to all parts of the building. The pressure on the air chambers is provided by an air compressor, manufactured by the New York Air Brake Company.

The hot-water house-service is obtained from a heater, the steam supply to which is controlled by a Curtis thermostat made by the Julian D'Este Company of Boston. On their steam supplies all the pumps are provided with Locke governors, making them automatic in their operation, and the feed, salt-water and house-service pumps have American Steam Gauge Company's water-relief valves, connecting the discharge and suction ends. The one on the feed pump opens at 200 pounds and the others at 100.

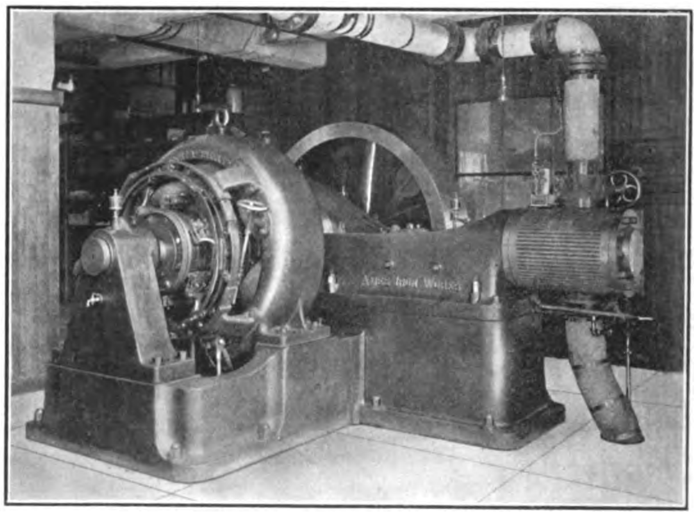


FIG. 5.—AUXILIARY GENERATING UNIT.

The exhaust steam from the pumps combining with that from the Ames engine goes into the low-pressure system for heating and manufacturing purposes. Condensation from this system and the drip from all clean steam pipes is withdrawn through V. D. Anderson steam traps and brought back to a receiver, 3 feet in diameter by 4 feet long, connecting with a Deane 8 x 5 x 12-inch horizontal return pump, which discharges direct to the boilers. Greasy drips such as those from the oil extractors or from parts of the exhaust piping containing unclean steam are discharged into the salt-water waste pipe. All traps are by-passed.

The feed-water heater is of the National closed type and receives steam from the low-pressure system, the excess being passed out through an 8-inch spiral-riveted galvanized-iron exhaust pipe, containing a Schutte back-pressure valve and leading to the roof, where it is surmounted with an exhaust head. This same riser has a connection to the large engine exhaust pipe, which contains an 8-inch Blake automatic exhaust relief valve.

In case of any trouble with the condenser this valve will open automatically and allow the engine to exhaust direct to the atmosphere. The feed pumps discharge through the heater, but they are also arranged to deliver cold water directly from the city mains to the boilers. The feed piping between the pumps and heater is of wrought iron and that between the heater and boilers is of brass, iron-size and thickness, as is also the discharge pipe from the return pump.

The refrigerating equipment operates on the ammonia absorption system, has a capacity of 100 tons of refrigeration per twenty-four hours, and was installed by the Carbondale Machine Company. It includes a Hendrick brine cooler, a generator, an absorber, two condensers, two ammonia pumps and two brine pumps. The connections and locations of the parts are clearly indicated in the accompanying plan. The ammonia pumps are cross-connected and of the same size and make, *i. e.*, Deane, 14 x 5½ x 12-inch pumps. The brine circulating pumps are also cross-connected and of Deane make, one having 14 x 8½ x 12-inch cylinders, and the other 7½ x 8½ x 10-inch. For the circulating of the drinking water a 3 x 2 x 3-inch duplex Warren pump is used, drawing from a supply tank, which is cooled by brine coils and kept filled by a float valve controlling a connection from the city service. All pumps are duplex with the exception of the ammonia pumps, and all are placed vertically except the ammonia pumps, brine pumps, drinking water pump and hot water return pump.

To Messrs. Dean and Main, of 53 State Street, Boston, engineers and mill architects, are due the structural features and general layout of the apparatus in the power plant, as well as the refrigerating system. Mr. E. F. Brigham, who remains in the employ of the company, was the engineer for the electrical work, and the present chief engineer in charge of the plant is Mr. F. C. Kennedy. The steam piping and heating system were installed by the Walworth Construction and Supply Company, of Boston.

INTERESTING CONDUIT WORK IN BROOKLYN.

The Brooklyn Heights Railroad Company had just had installed for it an interesting piece of conduit work running from its new power house on Gowanus Canal and First Street to Fifth Avenue and First Street, where the feeders emerge and are fastened to the elevated railway structure, supplying both elevated and surface railway demands. The feeders after leaving the direct-current switchboard pass downward along the wall of the power house to the floor of a compartment in the basement immediately beneath the switchboard. Here the feeders enter the conduit, spread out on the floor as shown in Fig. 1, and pass out of the building to a manhole at the northeast corner of the power station. From this manhole emanates a 72-duct line, arranged 9 high and 8 wide. The basement of the power house being on a level with the outside ground, the conduit runs along the ground, being encased in concrete as shown by Fig. 2, which is a view outside the new power house, the old power house being shown in the background. The street level is considerably higher than the ground upon which the power house is built, so that the conduit runs underground, as soon as it reaches the street, to a double manhole outside the station on First Street near Third Avenue. Before reaching the manhole, however, it is fanned out so that a 36-duct line enters one manhole and two 18-duct lines enter the other. These latter are arranged 9 high and 2 wide, while the former is arranged 9 high and 4 wide.

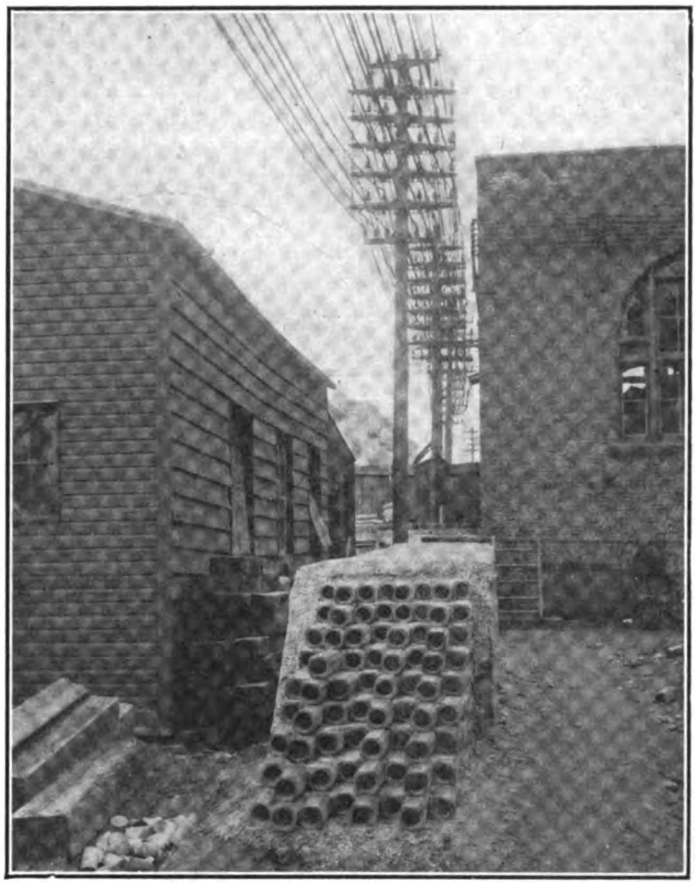


FIG. 2.—CONDUIT IN THE STATION GROUNDS.

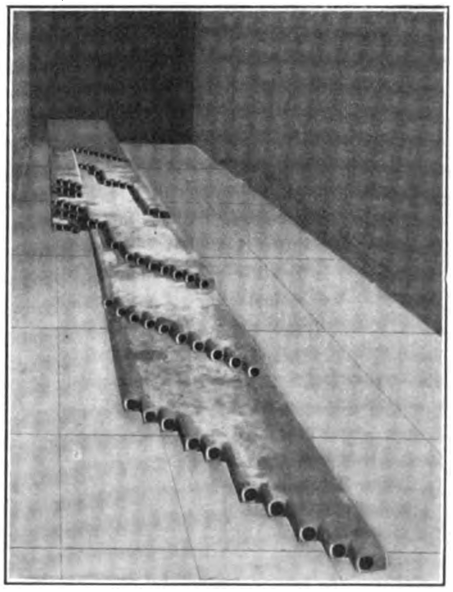


FIG. 1.—LAYOUT OF CONDUIT IN POWER HOUSE BASEMENT.

Serious difficulties were encountered at Third Avenue in the shape of water mains, gas mains and already existing conduit lines, the surmounting of which necessitated no little labor. The Third Avenue manhole is a vault 3 ft. 10 ins. wide, 6 ft. 4 ins. deep and 24 ft. long, having two covers. From

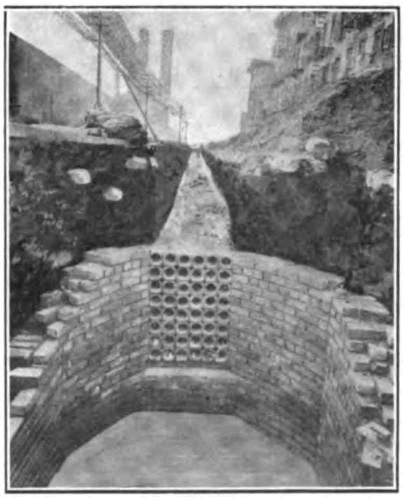


FIG. 3.—CONDUIT LINE ON FIRST STREET.

the 36-duct manhole, 33 ducts, 3 high and 11 wide, emanate in two conduit lines and enter the Third Avenue vault, one line containing 9 ducts and the other 24 ducts. From the manhole in which two 18-duct lines enter, 2 wide and 9 high, a 16-duct line 2 wide and 8 high runs to the far end of the Third Avenue vault and another 16-duct line, 4 wide and 4 high, enters the vault near the center well up toward the top. A 6-duct line runs parallel with Third Avenue from one end of the vault and a 16-duct line runs along Third Avenue from the other end. From the side of the vault, two 24-duct lines, 3 high and 8 wide, run to a manhole in the middle of First Street above Third Avenue, where they unite in a 48-duct line and run up First Street to a manhole at Fifth Avenue. Fig. 3 is a view of the conduit line on First Street. At Fifth Avenue, three 16-duct lines run to three manholes situated on the northwest, southeast and southwest corners, from which the feeders ascend along the pillars of the elevated railway structure. Fig. 4 is a diagrammatic view of the manholes and conduit layout at Third Avenue and shows how the conduit lines are arranged in order to pass the obstructions mentioned. The obstructions of course are not shown.

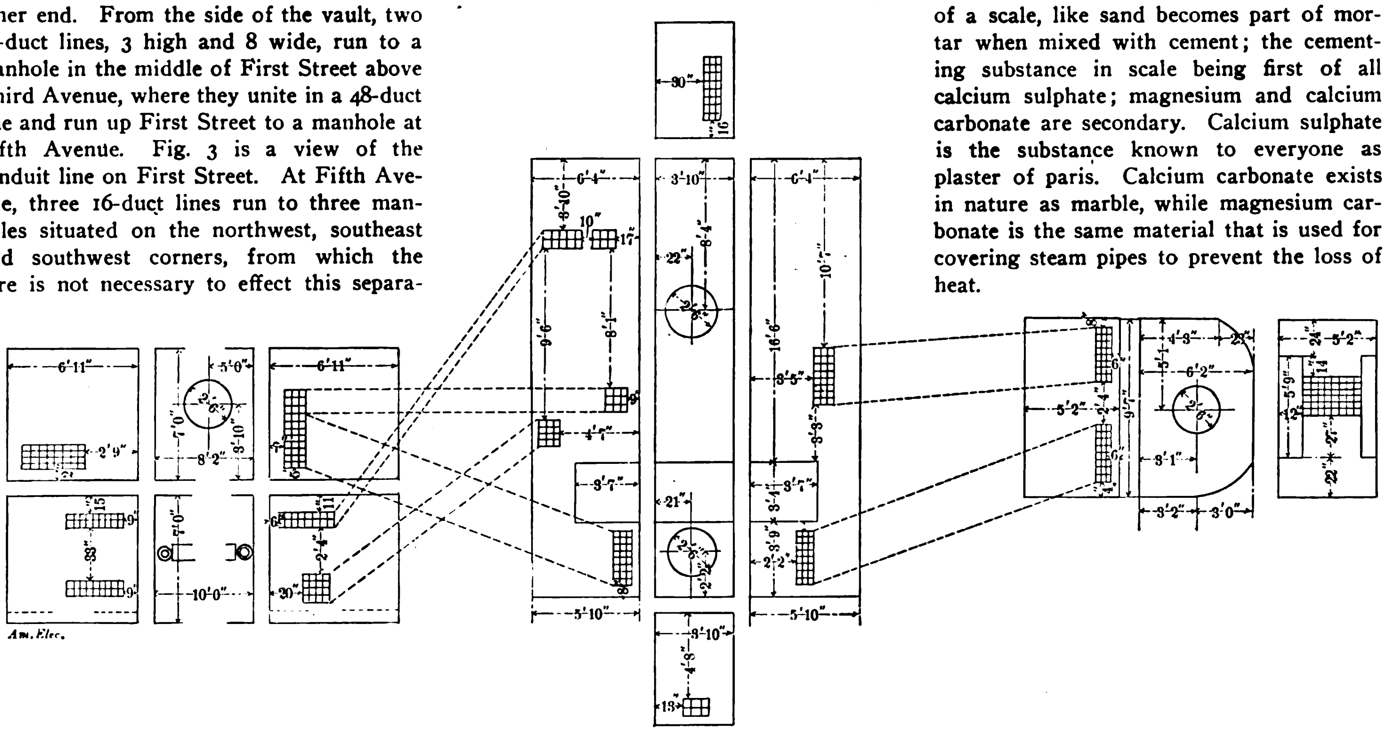


FIG. 4.—DIAGRAMMATIC VIEW OF CONDUIT LAYOUT AT THIRD AVENUE.

The contractor for the conduit work was Mr. G. M. Gest, of New York and Cincinnati.

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BOILER SCALE.

BY GEO. W. LORD.

That nearly every water used in manufacturing plants for the production of steam contains solids which, upon evaporation of the water, form boiler scale, is well known to engineers generally, but it does not appear to be so well known in what manner that scale is formed, or what chemical reactions take place to cause the formation. In order to divide these solids they may be classed separately as sulphates and carbonates. The carbonates are calcium carbonate and magnesium carbonate, both of which are held in solution by reason of their excess of carbonic acid. From a temperature of about 180° Fahr. to the boiling point and above this excess of carbonic acid is driven off, and the carbonate of lime, or magnesia, robbed of its solvent deposits. An exceptionally high temperature is not necessary to effect this separation, and it is for this reason that carbonates deposit in feed-water heaters and economizers, as well as at the point in the boiler where the feed-water enters. The carbonates, when existing in a water without any calcium sulphate being present, form a porous accumulation, varying from a crystalline to amorphous formation, and even occurring as a fine powder. The latter is more often the case when the feed-water contains in solution a considerable quantity of sodium chloride (common salt).

Calcium sulphate, which is held in solution by nearly every natural feed-water, and especially in England, is not precipitated at the comparatively low temperature mentioned. In an experiment made in our own laboratory a water heavily saturated with calcium sulphate was heated to a temperature producing ten pounds of pressure, but no precipitation of the calcium sulphate was caused. Some authorities claim that the separation, or the change of the calcium sulphate from solution to suspension, takes place on the surface of the water in the boiler. If this were a fact the calcium sulphate scale would accumulate in those parts of a boiler nearest the water surface. The contrary, however, is the case, as scale of this nature invariably forms at the parts of the boiler which are exposed to the highest temperature. It is for this reason that we claim that the actual separation from a certain quantity of water takes place the minute that quantity of water is changed into steam, and we claim that this change takes place at the point where the heat is transmitted through the iron of the boiler to the water.

When an atom of water reaches a sufficiently high temperature to become steam it forms a minute globule, rises through the water to the surface, where the slight coating of water covering the globule breaks. At the point where this globule is formed, that is, at the heating surface, there being nothing to hold the calcium sulphate either in suspension or solution, it must separate, and forms a very small crystal. If the ebullition of the water permits it to do so it will adhere to the iron at the point where it had its origin, or it may be carried by the circulation until it reaches something to which it can adhere. The scale which is formed of calcium sulphate alone is very hard, but a formation of this kind is rare, the great majority of scales consisting of the three substances mentioned, as well as other mineral and vegetable substances.

These latter substances, which are held in suspension by water instead of in solution, become part of a body of scale only mechanically. That is, they become part of a scale, like sand becomes part of mortar when mixed with cement; the cementing substance in scale being first of all calcium sulphate; magnesium and calcium carbonate are secondary. Calcium sulphate is the substance known to everyone as plaster of paris. Calcium carbonate exists in nature as marble, while magnesium carbonate is the same material that is used for covering steam pipes to prevent the loss of heat.

From the very nature of scale-forming substances their accumulation is a source of trouble to the engineer and expense to owners of plants. There are, no doubt, many cases where additional expense does not worry the engineer, but there are probably more cases where the additional trouble to the engineer does not worry the owner of the plant. There is no question, however, but that both would be benefited if the accumulation of the scale could be prevented and taken care of.

The problem is a rather difficult one, as not only does each source of water vary greatly in the scale-forming solids, but each individual source varies from time to time. One can readily see, therefore, that the analysis of a single gallon of water does not give a great deal of information, but the analysis of a sample of scale does give complete information, as each sample of scale represents the residue left after the evaporation of large quantities of water. We, therefore, contend that if a sample of scale is divided and separated into its various ingredients, chemical treatment can be undertaken successfully. Without such determination, however, it is impossible to provide reagents which on the average can be assured to give satisfactory results.

If it were possible to compute the loss in fuel alone from this cause, the results would reach an enormous total, and would call the attention of the owners and engineers of plants to the great importance of the subject.

New Apparatus and Appliances

HIGH-TENSION INSULATOR TESTS.

The accompanying illustrations show the results of some interesting tests made by The R. Thomas & Sons Company, of East Liverpool, Ohio, on their No. 14 C-T insulators. These are of brown glazed porcelain made from English china clay and are glaze-filled; the individual parts being dried separately in an oven by a process known as "biscuit firing," dipped in glazing material, fitted in each other, put in a sagger petticoat uppermost and placed in a kiln. The petticoats are thus welded together by seams of glass-like glaze, which, it is claimed, are stronger than any of the other parts of the insulator. For the purpose of determining the potentials that arc over them, the insulators were mounted on tin-covered wooden pins. Current was supplied by a 150-kw. testing set, the requisite potential being obtained by means of a step-up transformer. No dry test was made, as this is of little value, since the potential at which the arc jumps from the head to the pin can be predetermined by measuring the shortest distance between them and referring to a curve of arcing distances in air. In the wet arcing test a stream of water from a sprinkling nozzle was played on the insulator, the quantity of water thus striking the insulator amounting to ¾ inch per minute. The insulator shows by Fig. 1 was subjected to a potential of 57,000 volts before the current "jumped." In Fig. 2 the current arced to the pin when the potential was 87,000 volts. In Figs. 3 and 4 the insulators withstood a potential of 98,000 and 107,000 volts, respectively before the current flashed over to the pin. This type of insulator measures 13⅝ inches high, 14¼ inches in diameter and weighs 24 pounds. It is intended for 70,000-volt service.

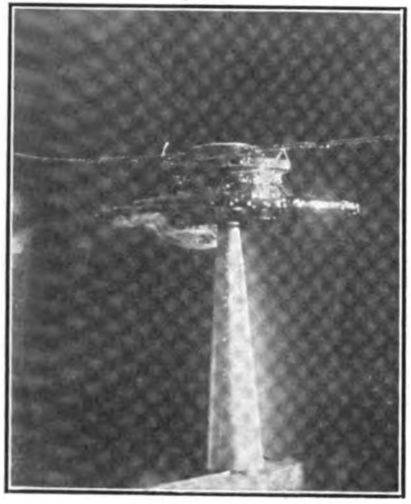

FIG. 1.

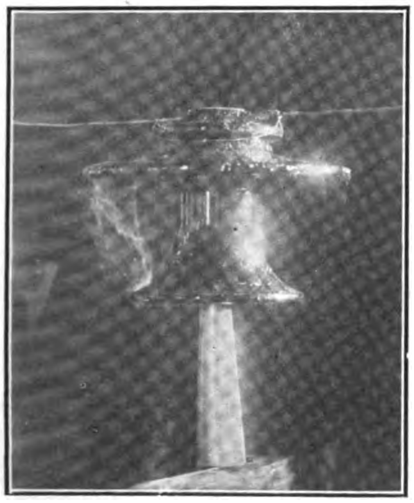

FIG. 2.

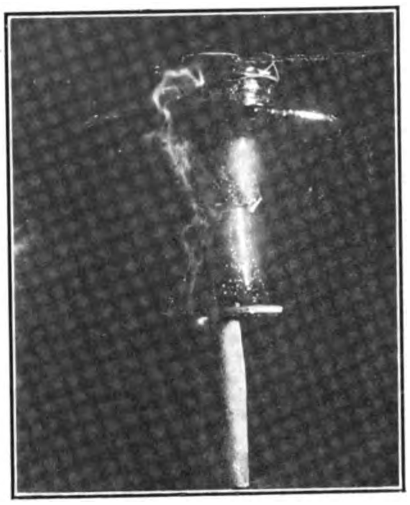

FIG. 3.

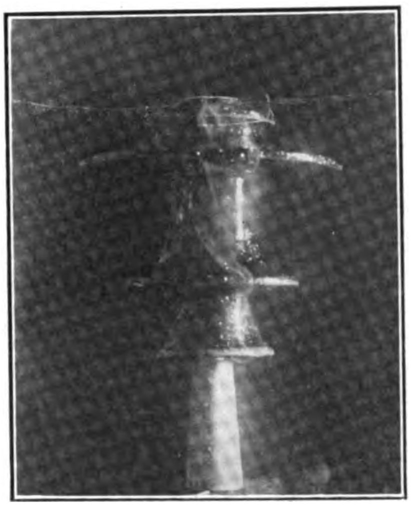

FIG. 4.

SIGNALING APPARATUS FOR CENTRAL STATIONS.

Charles Cory & Sons, of New York City, have brought out a modified form of ship telegraph apparatus for signaling between the engine room floor and elevated switchboard galleries. While this is rather unique in this class of work, it possesses obviously decided merit in generating stations of considerable size, especially if the switchboard attendant be more or less isolated from the engineer's natural post of duty, and where the use of some positive means of cummunication is an item of value in facilitating the rapid and accurate execution of orders. In marine practice for which this system was originally designed, there is used for each propelling engine one set of this apparatus, the set consisting of duplicate dial stands, one in the engine room and the other in the pilot house. A lever at each stand mechanically operates the indicating pointer on the other dial, a gong sounding also. Receipt of the order is acknowledged by placing the engine-room lever at the same position, the indicator on the pilot's dial showing that the order has been understood and is being obeyed. When the order has been executed the engineer may advise the pilot of the fact by moving his lever away from the ordered setting and immediately returning it thereto, this operation sounding the gong and calling attention to the accomplishment of the desired change. In adapting this signal system to power plant work, duplex sets of the apparatus are installed, two stands being used at each end as shown by Fig. 5. One indicates the unit and the other shows the order to be executed. This latter stand has its dial arranged to indicate the various details of manipulation which may require to be communicated either way between the engine-room floor and the switchboard galleries. Connections between the stations are mechanical, being made by means of rods and chains.

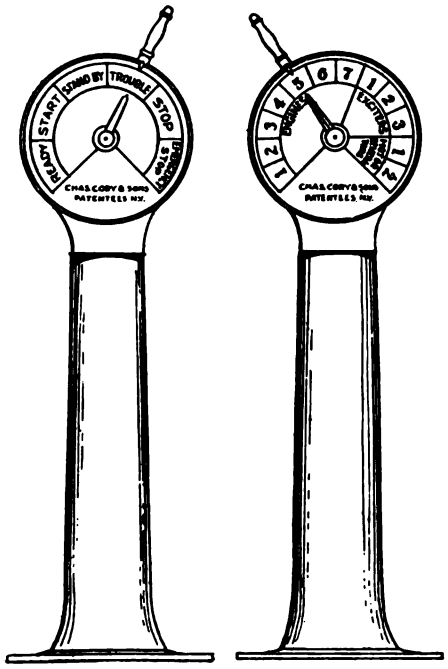

FIG. 5.—SIGNALING APPARATUS.

A NEW LINE OF DYNAMOS AND MOTORS.

The C. & C. Electric Company, New York, has brought out a new line of direct-current dynamos and motors in which special means for securing ventilation have been embodied, with the result that the maximum temperature rise, after running 24 hours under full load, is 30° C. (54° Fah.). The company's engineers have been at work nearly two years on this line of machines, perfecting their design and construction in the minutest details; they now have eight sizes of frame ready for the market, these eight sizes giving a range of outputs from 1 horse-power to 40 horse-power in slow and moderate speeds with corresponding dynamo ratings.

In brief the construction of the machine is as follows:—the magnetic frame, supporting brackets and magnet poles are of soft homogeneous cast steel; pole-shoes are bolted to the ends of the poles by bolts passing through from the outside. The field magnet coils are wound on insulated sheet iron spools. The self-oiling and self-aligning bearings and the brush rigging are carried by cast-iron brackets which are cast solid with the frame finishing rings. The armature is of the slotted hollow drum type wound with formed coils; the commutator is unusually large in diameter, composed of hard-drawn copper bars insulated with mica, and is attached to the shaft and the armature body by means of bolts, keys and set-screws; the brush holders are of the well-known "C & C" reaction type, carrying carbon brushes.

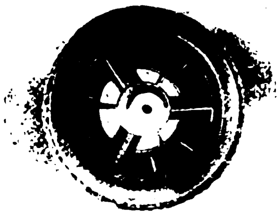
FIG. 6.—END VIEW OF ARMATURE.

The very low temperature rise is obtained by means of forced air circulation. The armature discs, are punched out of very soft sheet steel (which is subsequently oxidized for insulating purposes); adjacent to the center shaft-hole in the disc are three horse-shoe shaped holes, so punched that when the armature body is assembled on the shaft there are three axial tunnels next to the shaft. In the center of the armature body a spider, or spacing plate, is placed which has arms radiating from the ring by which this spider is attached to the shaft. The back and front end plates which clamp the armature body together, and which support the free ends of the armature coils, are also of the spider construction, their spokes also acting as fan vanes. The commutator shell also has arms projecting radially from its hub, forming additional fan vanes. The assembled armature therefore has three air passages running through from one end to the other, connecting with lateral passages in the middle of the body. When the armature is in operation the air is drawn in through the commutator shell at the front end and forced through the armature, part of it being discharged through the lateral passages in the middle of the armature body, and part going through the back end, thus creating a forced draft through the center of the armature and fanning the fields with cool air. An idea can be secured of the ventilation of this armature by a glance at Fig. 6 which shows a back end view of it.

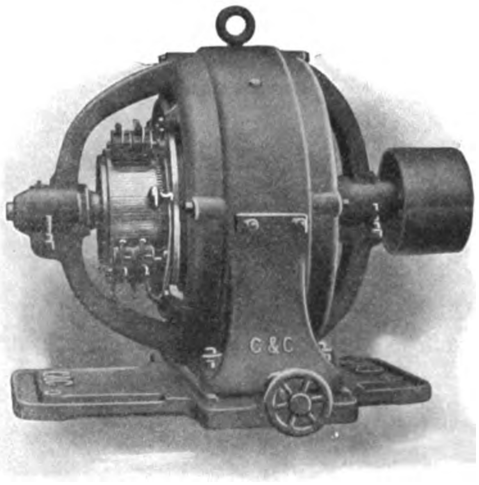

FIG. 7.—TYPE "S" C. & C. MOTOR.

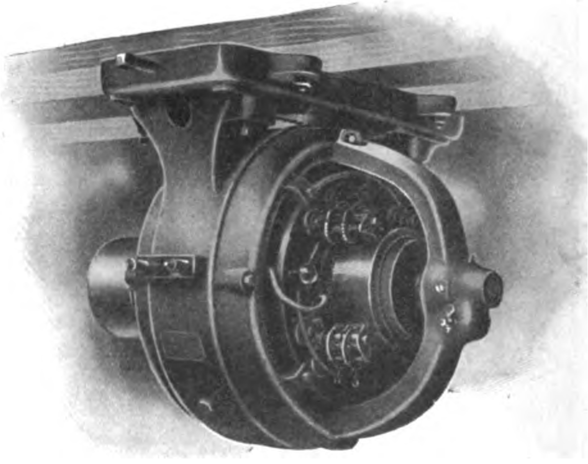
FIG. 8.—TYPE "S" C. & C. CEILING MOTOR.

The "Type S" machines are well adapted for mounting on machine tools for direct driving. Fig. 7 shows the standard form of the machine and Fig. 8 the ceiling type. The machines are also made in the entirely enclosed type, the semi-enclosed type and the vertical open and enclosed types.

CAPITAL AIR-COOLED GASOLINE MOTORS.

The Capital Gas Engine Company, Indianapolis, Ind., has brought out a line of very compact gasoline motors intended primarily for automobile purposes but adaptable to launch service also. Fig. 9 herewith shows a complete 2-cylinder engine, and Fig. 10 shows the same engine with one cylinder and the valves removed. the piston of the removed cylinder being shown supported on the end of its connecting-rod, which protrudes from the crank case. These little motors are of the four-stroke-cycle class and designed to run at 1100 to 1300 r.p.m., according to the load. Both the admission and exhaust valves are mechanically opened by means of cams, rollers and rocker-arms, so that a full charge is taken in each cylinder at each suction stroke. The valves are all provided with closing springs and each valve is mounted in a detachable cage or chamber,

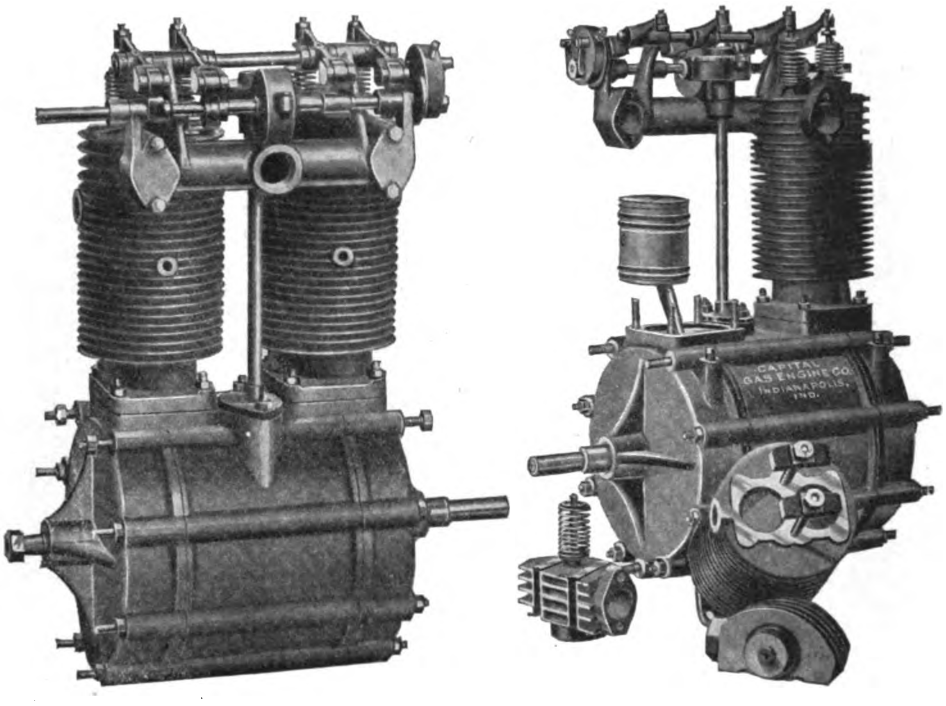

FIG. 9.—CAPITAL AIR-COOLED GASOLINE MOTOR.—FIG. 10.

as indicated in Fig. 10, where one of the valves and its chamber are shown near the end of the crank case. The valve chambers have deep flanges with ground joints which require no packing. The cams and rollers are of tool steel. The secondary shaft is mounted horizontally, as shown in Fig. 9, and driven through spiral gears by a vertical shaft which is shown rising from a stuffing box in the crank case, this shaft, of course, being driven from the main shaft by spiral gears. The igniter commutator is mounted on one end of the cam shaft; in Fig. 9 it is shown at the right-hand end and in Fig. 10 at the left-hand end, the two views being from opposite sides. Each cylinder is cast in a single piece with its head, so that no packing is required, as is the case with removable heads, of course. The spark plugs are located immediately within the path of the incoming charge, and it is stated that they do not foul. The crank-shaft is of forged steel in the smaller sizes and built up with heavy balance discs and tool-steel journals in the larger sizes. The crank-shaft journals are supported in three long phosphor-bronze sleeves in the four-cylinder engines and two sleeves in the two-cylinder and three-cylinder machines. Lubrication is automatic, all of the bearings being lubricated by oil contained in the crank case. A single mixing valve is used, which automatically mixes the gasoline and air in the proper proportion. Speed regulation is obtained by means of a throttle valve in the mixing chamber, which regulates the quantity of explosive mixture admitted to the cylinders. The two-cylinder engine is rated at 5 horse-power, the three-cylinder at 7½, and the four-cylinder machine at 10 horse-power. The height over all is 24 inches, the width transversely to the shaft 10 inches, and the length parallel with the shaft is 19 inches for the two-cylinder size. The three-cylinder and four-cylinder sizes are, of course, larger parallel with the shaft, but the other dimensions are unchanged.

U. S AUTOMATIC INJECTOR.

Fig. 11 herewith shows the U. S. automatic injector made by the American Injector Company of Detroit, Mich., who claims for it many points of vantage. Each injector is provided with a drip cock, which constitutes a distinctive feature. By this means the injector is drained when not in use, and may be started even with the check valve closed. The injector, it is also claimed, will start with lower steam. Moreover by leaving the drip-cock open when not in use, it prevents the suction pipe from getting hot, or jet from liming up when steam or check valve leaks. Another feature of the injector to which the manufacturer draws attention is the construction of the disc valve on the delivery tube, which being cup-shaped, is forced to rise to its seat by the jets of water thrown against it from beneath. This causes it to operate, it is said, even where there is a formation of limey deposit on the tube. Fig. 12 is a cross-section showing the internal arrangement of the injector, and Fig. 13 shows the various parts. Here *A* is a steam jet; *B* the suction jet; *C* the delivery tube; *D* the tail pipe; *E* the tail pipe nut; *F* the delivery cap; *G* the overflow cap; and *H* the overflow valve. The steam, water, overflow and boiler connections are clearly indicated in Fig. 11, so that the construction of the injector and its operation are easily followed from the engravings.

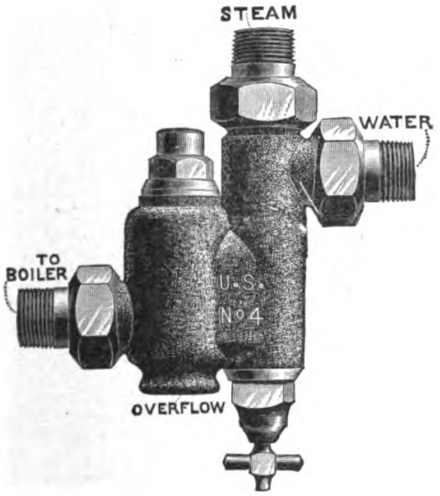

FIG. 11.—U. S. AUTOMATIC INJECTOR.

FORCE FEED LUBRICATOR.

Fig. 14 herewith shows one of the latest inventions in the line of force feed lubricators brought out by the Penberthy Injector Company, of Detroit, Mich. One of its main features is found in the use of two ratchets, one of which drives the plunger while the other acts on the plunger itself. The ratchets are interchangeable, so that when the "dog" will no longer hold on the outer ratchet, which is most subjected to wear, this can be replaced by the ratchet acting on the plunger and vice versa. The valves are placed in the center of the oil reservoir where they cannot be affected by changes of temperature. By closing the jaws of the lubricator with the nut *B* the feed is increased, whereas the opposite is true if the jaws are opened. When the proper amount of oil is being fed, the lock nut *D* is screwed down so as to hold the nut *B* in place. Extra oil can be secured by screwing down the nut *B* and operating the plunger by hand. A hole is provided in the bottom of the cup so that the latter may be readily cleaned.

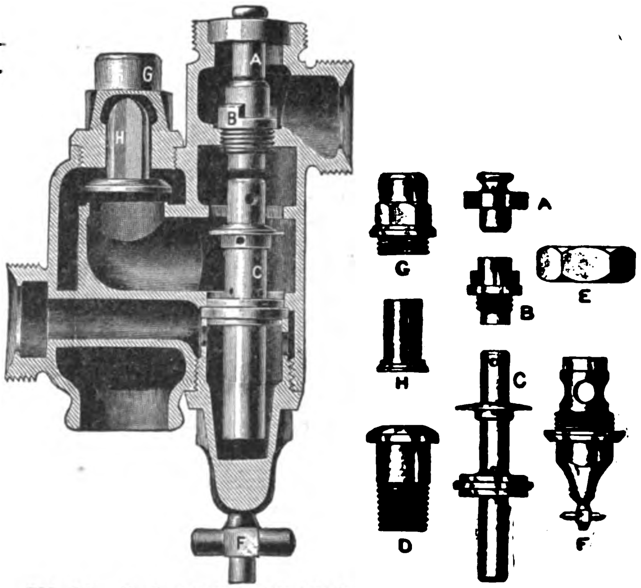

FIG. 12.—U. S. AUTOMATIC INJECTOR AND PARTS.—FIG. 13.

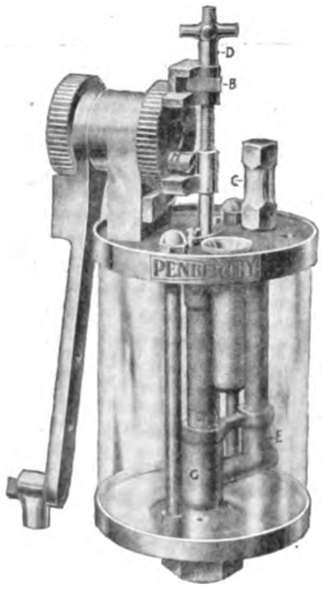

FIG. 14.—FORCE FEED LUBRICATOR.

OIL CAR CIRCUIT BREAKERS.

The use of circuit breakers as a means of protecting the car equipment from dangerous overloads has become quite general and has led to the development of several different types of breakers designed especially for this class of service. The oil car circuit breaker herewith shown, manufactured by the Hartman Circuit Breaker Company, of Mansfield, Ohio, is designed to take the place of the fuse-block and hood-switch of the car. It automatically opens the circuit in case of overload on short circuit and can be operated by hand as readily as the usual hood-switch. The switch and current-carrying parts are immersed in oil within a tight cast-iron case. The feature of oil insulation permits of very compact and simple construction. The distinctive feature of the circuit breaker, however, is the use of a series break, consisting of five double-break plug contacts connected in such manner as to give ten breaks in series. The circuit is said to be broken simultaneously at ten distinct points, and the break taking place in oil,

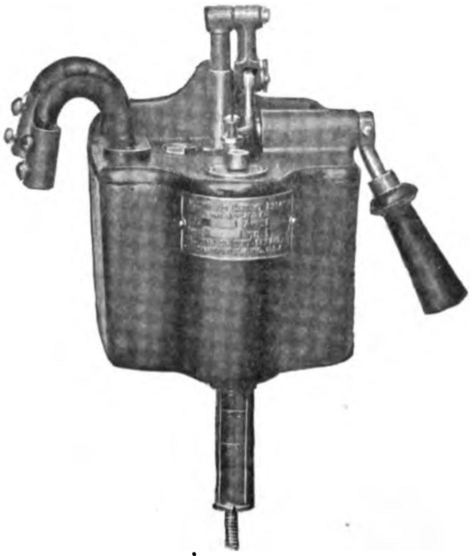

FIG. 15.—HARTMAN CIRCUIT-BREAKER.

there is no destructive arcing. The operating mechanism consists of a vertical rod, to the lower end of which are attached the movable bridging contacts. The rod operates in a brass bearing and is controlled by a toggle. A slight turn of the handle will cause the toggle to straighten out, thus raising the contact rod and effecting the closing and locking of the switch. The tripping coil is immersed in oil within the case, and, when an overload occurs, the plunger or core operating within the brass tube of the solenoid, delivers a strong hammer blow against an extension of the lower joint of the toggle, throwing the toggle out of center and effecting the opening of the switch. Ample space is provided between the live parts of the switch and the cast-iron case, and, as an additional precaution against grounding, the case is lined with insulating cement. Connection to the outside circuit is made within the case by means of insulated cable.

THE REEVES VERTICAL CROSS-COMPOUND ENGINE.

Any refinements on improvements that add to economy, efficiency and convenient handling of a steam engine, when of a nature that lessens personal attention and assures constant operation, are always appreciated by engineers, and this article, which briefly describes some of the features employed in the Reeves engine built by the Reeves Engine Company, of Trenton, N. J., will, we believe, be of interest. Fig. 17 shows a cross-compound engine built by this company, the design of which permits of the development of great power within very small floor space, and provides for easy access and adjustment of all of the parts. Chief interest will probably be centered in the steam distribution and valves of the engine, a section through the cylinders and valves of which is given in Fig. 19. This shows the high-pressure piston about to start on its downward stroke, the low pressure on its upward. The admission valve is moving upward, admitting steam on the top of the high pressure piston and across through the connecting port *B*, and around the head of the main valve. At the same time the main, or centre, valve is moving upward, admitting steam under the low pressure piston. This is the exhaust steam from the previous stroke of the high pressure piston, and it passes through the port *B* around the neck of the main valve and through port *C* into the bottom of the low pressure cylinder. When the pistons have moved about three-eighths of their stroke the admission port has been opened and admission valve returned to point of cut-off. The main, or centre, valve is now moving upward and finally closes port *C*. At this point compression commences in the high pressure cylinder and continues until the main valve opens port *C* again; meanwhile the main valve closed the upper port and compression took place in the low pressure cylinder. The steam distribution gives practically an equal division of work in the high and low pressure cylinders and there being no receiver employed, losses from free expansion and condensation are obviated. The engines are so designed that either cylinder can be used, independently of the other, should necessity require. The chamber *A*, around the sleeve in which the admission works, acts as a separator and is drained, as can be seen, at the extreme lower end. The sleeve receives the direct impact of the steam instead of the valve, and the valve is absolutely balanced, as all its exposed surfaces are under constant uniform pressure. Each of the three openings in the sleeve are larger than the steam pipe, therefore, the steam is not wire drawn in passing to the cavity inside the sleeve. The cubical capacity of chamber *A* together with space inside of the sleeve is greater than the amount of steam the high pressure cylinder can take, up to ¾ cut-off, and, as a result, the cards show remarkable steam lines, the actual difference between the initial cylinder pressure and pipe line pressure being extremely small. The space formed by the separator acts as a storage from which the engine draws its supply of steam.

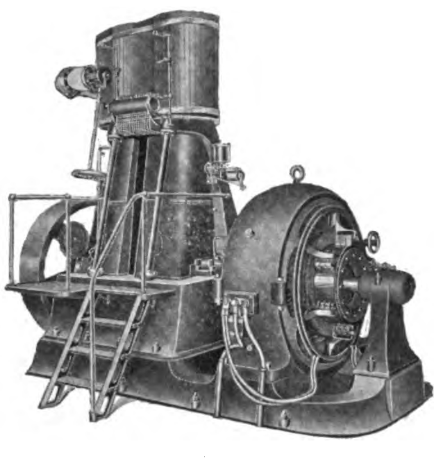
FIG. 17.—REEVES CROSS-COMPOUND ENGINE

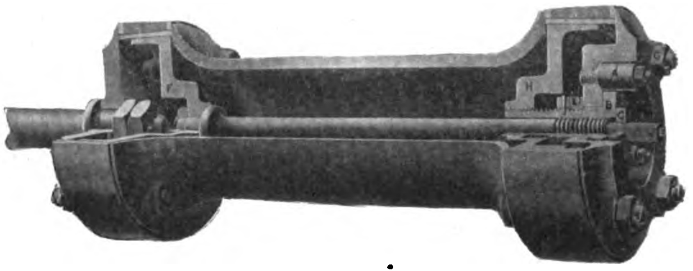
FIG. 18.—PISTON VALVE OF REEVES ENGINE.

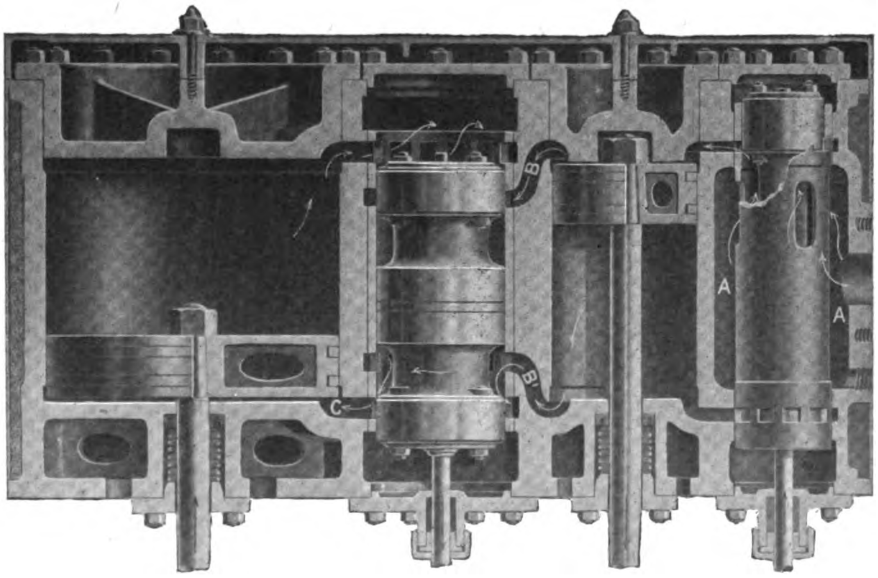

FIG. 19.—CROSS-SECTION THROUGH CYLINDERS AND VALVES OF REEVES ENGINE.

The separator being so close to the high pressure cylinder acts also to a degree as a superheater, so that instead of being a source of loss it is here a direct gain because it is evident that any heat it may lose must be taken up by the cylinder. This cut also illustrates very forcibly that there is no repassing of steam over same surfaces, which is, in itself, a guarantee of economy. The low cylinder heads are cast integral with the cylinders which reduces the number of joints to keep tight. The piston valves are readily adjustable at each end independently and without removal from the valve cylinder. This result is obtained by means of the construction shown in Fig. 18. Regulation of these engines is guaranteed to be within three-quarters of one per cent., this remarkable result being secured by having the intermediate valve driven by a fixed eccentric which thus gives a compression in the high-pressure cylinder that varies with the load. The high-pressure valve is worked from an eccentric controlled by a Rites governor of very simple construction. This governor embodies a unique feature in that the suspension pin is turned slightly by a ratchet each time the engine starts or stops, preventing uneven wear.

NEW BOOKS.

The Indicator Handbook. Part I. Second Edition. By Charles N. Pickworth. New York: D. Van Nostrand Comapny. Buckram; 130 pages, 5 ins. x 7½ ins.; 81 illustrations. Price, $1.50.

The present edition of this handy little book is like the first edition in all particulars which do not change with time. The chapter describing the different makes of indicator has been revised in accordance with the changes in construction which

American Electrician.

Vol. XVI. New York, May, 1904. No. 5.

INDEPENDENT TELEPHONE DEVELOPMENT IN THE NORTHEAST.

AUTOMATIC TELEPHONE EXCHANGE OF THE NORTHEASTERN TELEPHONE COMPANY, AT PORTLAND, MAINE.

In 1882 the Dirigo Telephone Company of Maine was organized in the city of Portland, with an authorized capitalization of $500,000. It, therefore, claims to be the oldest independent telephone company in the United States, continuously in service. It received a special and extremely liberal charter from the state in 1883, giving it general and unlimited rights to construct its lines along and upon all highways, over railways, canals and bridges; in conjunction with the right to build underground and submarine construction, additional to the right of eminent domain. This charter preceded any legislation governing telephone line construction, hence its broad and unlimited character.

In 1895 the company began to extend its lines in the rural communities from Farmington in Northwestern Maine, toward Portland, the chief commercial city of the state. In 1900 the management of the company was acquired by Mr. Lewis A. Goudy, who had been interested in the development of other competitive public service facilities in the city of Portland, as a member of the city council. From the beginning of Mr. Goudy's connection with the company, to the present, the battle for expansion of the independent telephone business in the Northeast, has been continuous and most aggressive.

In 1902 the company's name was changed to the Northeastern Telephone Company, giving it a broader application. Mr.

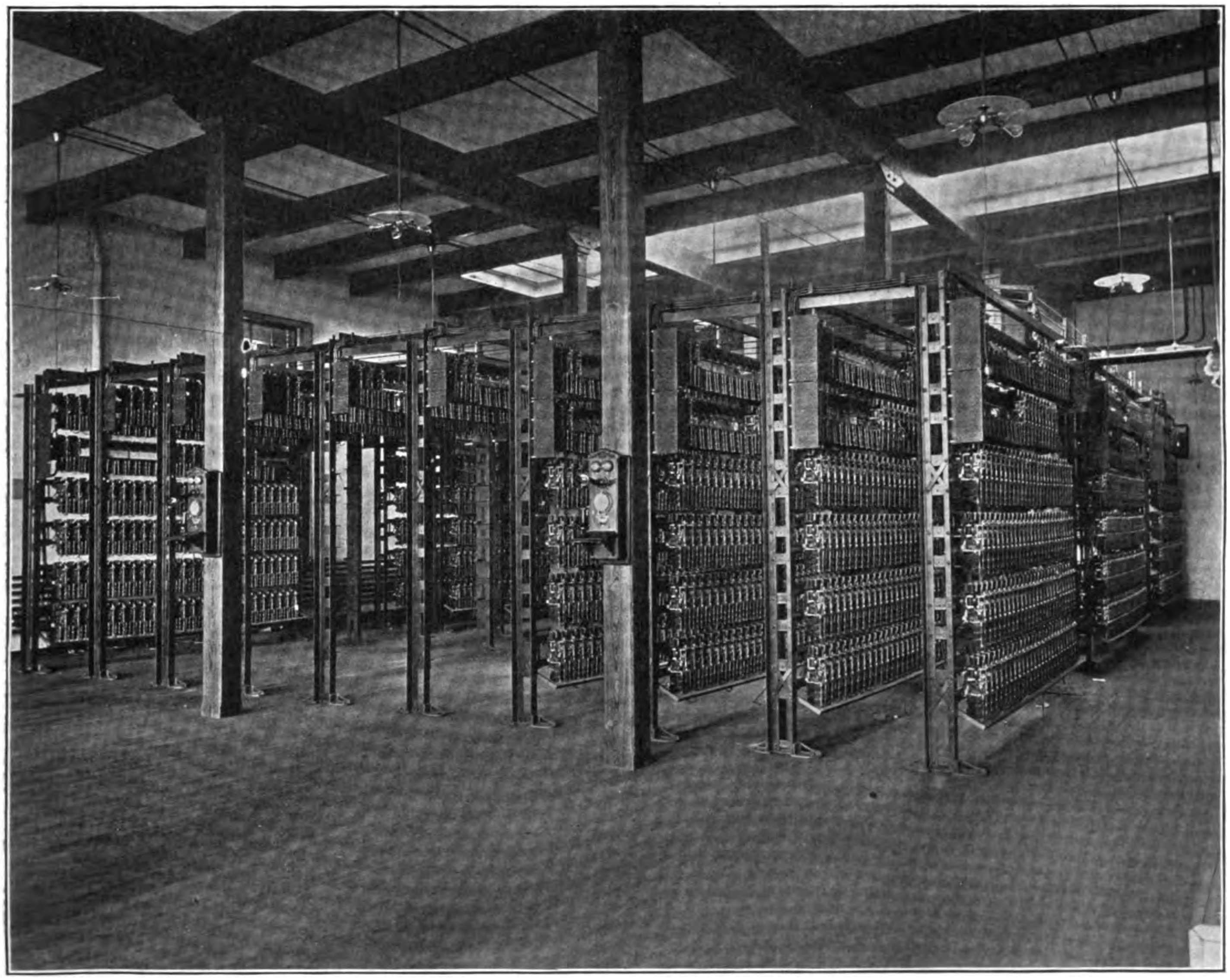

FIG. 1.—GROUP OF AUTOMATIC SWITCHBOARDS IN THE NORTHEASTERN TELEPHONE COMPANY'S EXCHANGE.

Thomas R. Brooks, of Scranton, Pa., was elected president; Edwin W. Gearhart, of Scranton, Pa., treasurer, and L. A. Goudy, vice-president and general manager. At the time the company's name was changed it had completed its trunk line from northwestern Maine through to Portland (the principal city of the state), and was the only company which owned its complete long-distance trunk or toll lines, in conjunction with its rural village and city installation and connections.

During 1903 the company constructed a new exchange building for the general headquarters of the company in Portland, costing nearly $40,000. Installation of its underground system, and aerial lines has cost several hundred thousand dollars, being sufficient to accommodate 5000 subscribers on outside construction, with an ultimate exchange capacity for 10,000. Two thousand five hundred automatic switches are already installed in the exchange, with which nearly 1500 instruments have been connected within the past three months, with some 700 contracts for subsequent installation, which the company expects will reach the full capacity limit during 1904, for the switches already installed.

The building in which the automatic exchange of the Northeastern Telephone Company is housed is constructed of brick and stone. It has a ground area of 3500 feet. Its floor space above basement amounts to 10,000 feet. It is three stories in height. The interior construction consists of iron girders, hard pine with wire lathing and no air spaces. The large basement contains steam heating apparatus enclosed in a fire-proof room, fuel compartment, large fire-proof vault for office supplies, maps and papers, fire-proof tunnel for underground cables from the company's conduit system; the remainder of the basement being used as a general stock room. The first floor consists of business offices, a fire-proof vault, director's, manager's, engineer's, superintendent's, manager of contracting and assistant engineer's departments with public reception room, long-distance booths, etc. The second floor is used for battery rooms (a view of the batteries being shown by Fig. 3 herewith), distributing rack, and testing station. On the third floor are to be found the switchboards with 2500 switches installed for immediate connection and with extra racks sufficient to accommodate 500 additional switches. There is enough surplus room for 2000 switches, giving an ultimate capacity for 5000 subscribers on this floor. This room is lighted by double glass skylights. The building is fire-proof throughout.

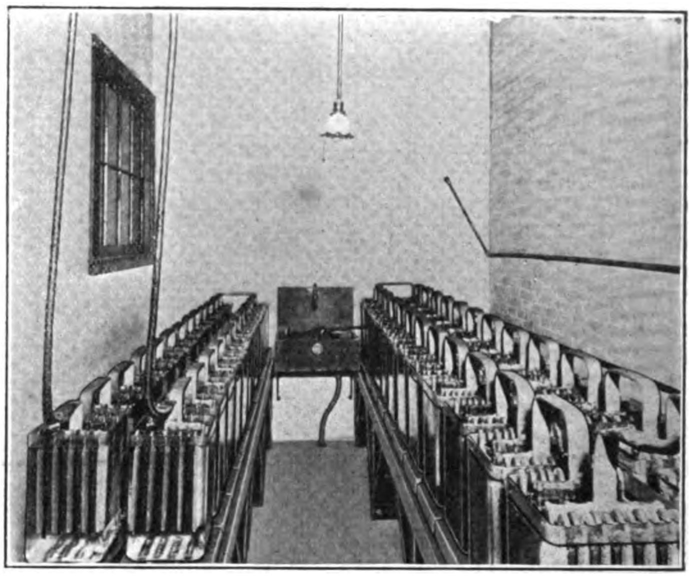

FIG. 3.—STORAGE BATTERY EQUIPMENT.

Fig. 1 shows the group of switchboards arranged in three tiers of 10 boards each; each tier representing 1000 subscribers. The open space at the center of the first tier will be used for increasing the exchange from 2500 to 3000 subscribers. This increase will be made by placing additional shelves with 25 switches on each shelf in frames already established. The cables connecting the different groups and shelves can be seen leading from the terminal heads on the end of each board along the top of the iron frame, which joins the boards together.

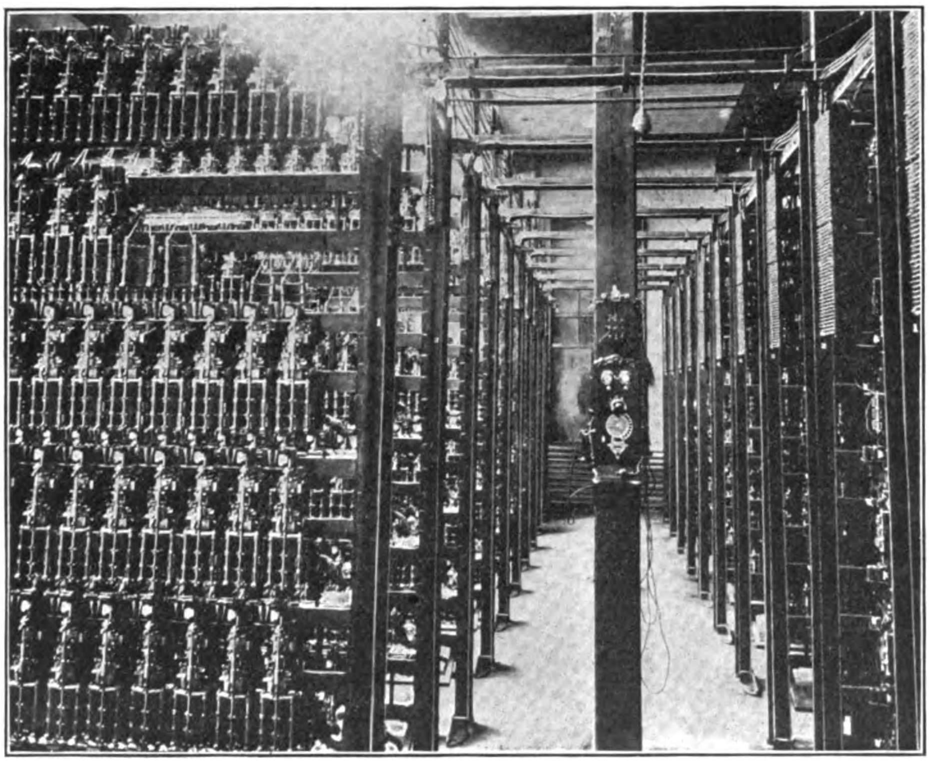

FIG. 2.—AISLE LEADING BETWEEN THE 1000 AND 2000 GROUPS OF SWITCHES.

Fig. 2 shows an isle leading between the 1000 and 2000 groups of switches. The entire power equipment of this exchange is in duplicate. The batteries are arranged in two series of 26 cells each; one of 200 ampere hours capacity and the other of 300 ampere hours. The terminals of the cells are burned together in the customary manner, the cells being supported on a substantial stand in such a way that the wooden block on which each cell rests is insulated by porcelain knobs from the remainder of the rack.

The charging machines, ringing machines and interrupter machines with power board are shown in Fig. 4. Each charging machine consists of a General Electric Company's two-phase, 60-cycle motor directly connected to a 75-volt generator. The ringing machines are of Holtzer-Cabot make; one consists of a two-phase, 60-cycle motor directly connected to a ringing generator. This machine is operated from a commercial power circuit. The other ringing machine is a dynamotor which is operated by the storage battery current, and is used at night or in case of a breakdown of the larger machines during the day. The two interrupter machines shown in the glass case are used to furnish the interrupter current for automatic switches, and they also carry busy back and holler wheels. These are operated from a storage battery. All of the power machines rest on a substantial foundation built of brick and covered with white tile. The power board consists of three marble slabs equipped with necessary knife switches, enclosed fuses, Weston ammeter, overload and underload circuit breakers for the charging circuit and with the necessary field regulators for the charging generator. Just beyond the power board stands a lamp board or tell tale board on which are the signal lamps which connect the section of the switchboard on which a fuse or heat coil may have blown. These lamps are mounted on a slate slab supported by iron frame work.

The operation of the automatic telephone is already familiar to most telephone people throughout the country. The telephone itself consists of the usual telephone box equipped with ringer, transmitter, receiver and induction coil, but with the addition of a calling device inside the box connected to the center of a revolving dial on the outside. Around the edge of this dial are ten finger holes numbered from 0 to 10 consecutively. To call a number, say 2345, the finger is first placed in hole No. 2 and the dial turned until the finger reaches the stop just below the dial. The dial is then released and is carried back to normal position by a spring. The finger is then placed successively in Nos. 3, 4 and 5, and the dial turned in the same manner. The button is then pressed which rings the bell of telephone 2345. The switch action at the central station when such a call is made will be as follows: When the first turn with the finger in No. 2 is made, a first selector switch is energized which selects a trunk line leading into the group 2000. With the next movement in hole No. 3, a second selector switch is energized and a trunk line selected leading into group 300 of the group 2000 already selected. The next two movements operate a connector switch which gives the tens and units of the call, and connects the calling subscriber with the line of subscriber 2345.

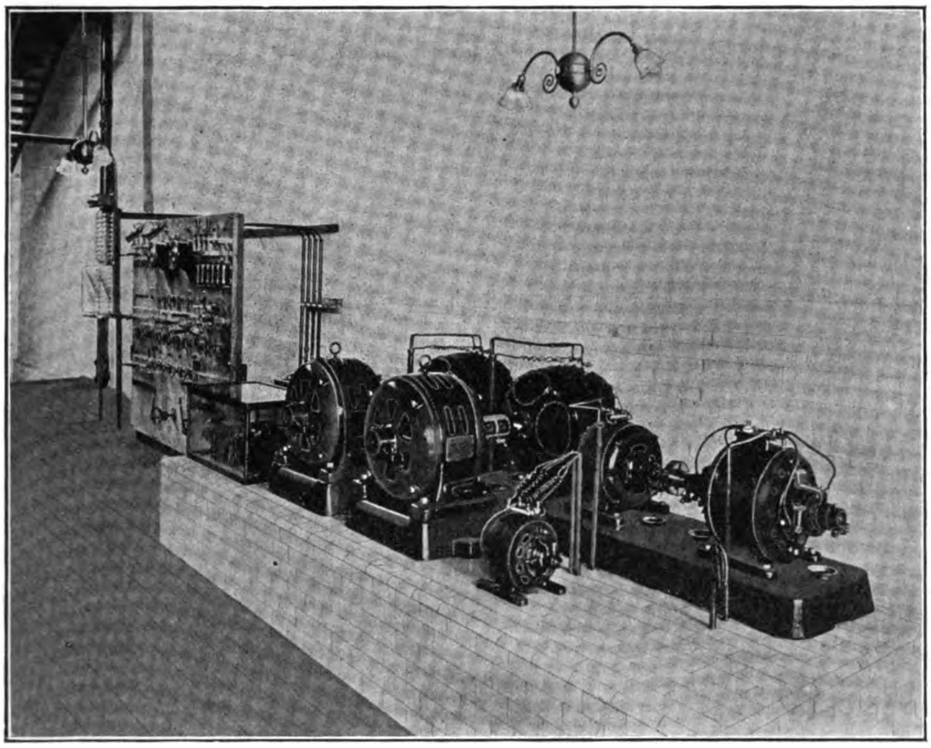

FIG. 4.—CHARGING, RINGING AND INTERRUPTER MACHINES, WITH SWITCHBOARD.

The Northeastern Company now has some 250 miles of rural pole line construction, with about 175 miles of trunk line, connecting between 60 and 70 towns, villages and cities in northwestern Maine, with 12 exchanges and 75 to 80 pay stations outside of Portland. It connects with several rural and farmer line independent companies covering territory adjacent to the company's main lines. It is also, under its licensee company's management, the Lewiston-Auburn Telephone Company, preparing to build an exchange for those two cities, connecting by trunk line with the company's main exchange in Portland, 35 miles away.

THE STEAM TURBINE SITUATION.

BY A. M. EARL.

During the past four or five years, the electrical and mechanical engineering fraternity has been treated to a great many stimulating doses of theory and prophecy by the advocates of the steam turbine. So stimulating have these doses proved that it is a serious question whether some of us have not been thrown a little off our balance, and it may be pertinent to inquire if it is not time to sober down—or up—tie a wet towel around our heads, and try to do a little straight thinking.

To begin with:—"Where are we at?"

The development of the steam engine covers, virtually, a period of 125 years. The steam turbine, as a commercial machine, is about twenty years old. It does not follow, as some have argued, that the turbine is, relatively to its ultimate development, where the engine was at a corresponding age. The development of the engine was slow because during the life of Watt and his coworkers, and for many years thereafter, metallurgy was practically an unknown science; the laws of physics and chemistry were little understood; there were no iron foundries or forge shops to speak of; there was comparatively little demand for steam power; the public was sceptical; capital was timid, and, perhaps most important of all, there were no trained engineers and no precedents to guide. The development of the turbine has been as rapid as that of the engine was slow because it has had every possible advantage:—splendidly equipped shops, a large demand, enthusiastic public support, unlimited capital, brains and experience by no means exhaust the list.

It can hardly be denied that today, with respect to development, the Parsons turbine is on the same plane as the engine, and there is no evident reason why the engine, from now on, should not improve just as fast as this type of turbine.

The Curtis turbine is, commercially, still in the experimental stage and it may be several years before the predictions which have been made for it can be verified or disproved from actual experience; the most that can be said today is that the somewhat meagre reports of machines in actual service indicate limitations which render it very doubtful if the hopes of the designers will be fully realized.

In the smaller sizes there is a moderate demand for the De Laval turbine, but its manufacturers long ago abandoned the idea, if they ever held it, that it was to revolutionize the engine industry.

I have been assured that the talent engaged in the development of the turbine is of such an eminent and able character that the difficulties now besetting its path will all be overcome. Such an argument is not only inconclusive, it is illogical and even absurb. Several hundred just as able designers of steam engines have been for years, and are now, wearing their gray matter into shreds and tatters trying to overcome certain limitations in their product. Sometimes they have had partial success; in other instances they have found it necessary to retreat. By one consideration or another, physical, chemical, mechanical, or commercial, the boundaries are defined beyond which they cannot go. There is a limiting steam pressure, superheat, vacuum, rotative speed, piston speed, bearing speed, size of low pressure cylinder, degree of regulation, pressure on bearing surfaces, cylinder clearance — and so on down the long list.

A few years ago, we were assured that the coming thing in electric power plants was the quadruple expansion engine working under an initial pressure of 250 lbs. or more; it was tried, and so were triple expansion engines; today, the quadruples that are in actual service can be counted on the fingers of one hand with fingers to spare, and you will have accounted for the triples before reaching the last of your toes.

Then came the craze for high degrees of superheat. Well—there seems to be a perceptible drift in opinion back to the position of the conservative old fogies who thought that at a superheat of 125° Fahr. the central station manager had secured about all the benefit that could be profitably extracted, all things considered.

Now comes the turbine; but its creators should not forget that they are human, of the same humanity as engine builders, and their product, if not subject to the same, will be subject to similar limitations. For example, the steam consumption of the turbine has been a disappointment; there is an increasing preponderance of evidence that the turbine, under similar conditions, does not compare favorably with the better types of reciprocating engines, and this fact will go far toward offsetting any difference in the first cost of the station as a whole.

Recent tests indicate a probable limit to superheat that may prove to be not far above the economical limit for engines. High temperature means large expansion and large clearances with a correspondingly decreased economy. Furthermore, high temperature can only be secured by increased coal consumption and after a certain point is reached the saving in the turbine is largely offset by the loss in the superheater.

It is doubtful if the high vacuums talked about can be maintained, at least, with a resulting gain commensurate with the cost. A vacuum of 29 inches is not hard to obtain when the apparatus is new, the engineer interested, and experts keep everything tuned to concert pitch. Will it remain 29 inches when the packing gets worn, the tubes begin to deteriorate, the engineer is busy, and the experts have gone home? Furthermore, blades wear and strip; governors get out of order; bearings heat and cut; lack of perfect mechanical balance creates disturbances; and so on down the list—just as long, just as serious, just as difficult of solution as the engine problem list.

Few people realize the remarkable adaptability of the steam engine. In this respect, the turbine compares most unfavorably with it. The steam engine can operate under high, medium or low steam pressures, with superheated, dry or wet steam; at high, medium or low speeds; can be built simple, compound, triple or quadruple expansion; horizontal or vertical; to run forward or backward; condensing or non-condensing; direct-coupled, belted or geared. This is certainly an impressive list of practical qualifications. Furthermore, the engine is not as sensitive to changes in operating conditions as the turbine. The same engine will give very fair results if supplied with wet instead of superheated steam, if thrown from the condenser to the atmosphere, and under varying steam pressures.

I trust the reader will not misunderstand my position. I do not say that the turbine is a failure; on the contrary, I believe it has a field which it will fill with a reasonable degree of satisfaction (and so also has the gas engine); but I wish to point out that the reciprocating steam engine has secured its present prominence by force of sheer merit, that as an all around mechanical athlete it is unsurpassed by any other form of motive power, and that the turbine will have to show a very considerable advance over its present record both as to economy, reliability and adaptability before it can hope to drive the steam engine into obscurity.

It is more probable that the outcome will be a gradual specialization brought about by the test of experience, and resulting in the selection of the prime mover best suited to the conditions attaching to each particular problem. This prime mover may be a steam engine, a gas engine, an oil engine, a steam turbine, a water turbine, or what not; but the greatest of these is the steam engine.

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STEAM ENGINE SPEED REGULATION.

BY J. J. M'GUIRE.

The governor, as applied to any type of engine, has a double purpose. First, it must prevent racing, and must not allow the speed to exceed a certain defined limit. Second, it must regulate the heat energy supplied to the engine, so as to maintain the proper ratio between that energy and the load under which the engine is working. In the water-wheel, for example, it opens or closes the gate more or less, thus supplying more or less water, as the conditions require, and in the steam engine it varies either the pressure or the amount of steam used. It is driven by the motor it regulates and is usually so constructed that any variation in the speed of the motor will cause the governor to check that variation in speed automatically. The operation of most governors depends upon counteracting the centrifugal force generated in a rapidly revolving body, by some other force, such as gravity or the tension of a spring.

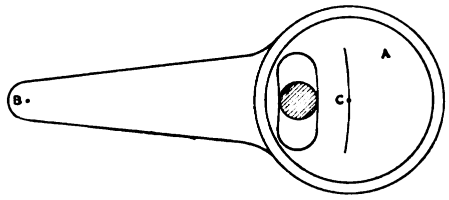

FIG. 1.

One of the oldest and most common forms of governors is the pendulum or so-called "fly-ball" governor, but on account of the number of parts it is difficult to construct and its variation in height for a given variation in speed is very small so that it is hard to regulate for high speeds. By the "height" of a pendulum governor is meant the distance from that point where two lines intersect that are drawn through the centers of the balls and their links, to the plane in which the balls revolve. It might also be added that the height of a revolving pendulum is independent of the weight of the balls or the length of the links and depends solely upon the number of revolutions.

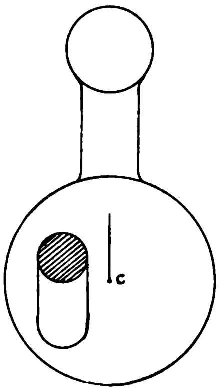

FIG. 2.

The variation in the opening of the throttle valve can only be caused by a variation in the height of the governor, which variation, in height, is in turn due to a change in speed. Hence the governor cannot control the speed except within certain limits. A well-designed engine will not vary more than 2 per cent above or below a specified speed. Therefore, to move the valve through its full range of action, the governor must be so constructed that it will have sufficient variation in height due to these two extremes of speed. When an engine is running at 100 revolutions per minute, with an ordinary pendulum governor, the height of the governor is 3.529 inches, and the allowable variation for this speed is only .14 inch, which, as will be readily seen, is a very small amount to control the working of a cut-off mechanism, or throttle valve, throughout its whole range of action.

With the introduction of modern high-speed engines it became very evident that a governor with fewer parts, and one that would give close regulation at high speeds was necessary. This end the shaft governor is specially designed to attain. The shaft governor derives its name from the fact that it is mounted on the main shaft of the engine. It consists of revolving weights the centrifugal force of which is balanced by means of springs. There are different types of shaft governors, but they are all based on the principle of changing the position of the eccentric center with reference to the shaft, and thereby changing the point of cut-off.

A simple form of shaft governor consists of the arrangement shown in Fig. 1, where *A* is the eccentric from which the slide valve is worked. In this arrangement there is a slot cut in the eccentric, as shown, which permits the center *C* to move in an arc of a circle the center of which is at the point *B*, at which the eccentric arm is pivoted. This movement of the eccentric, which is produced by the centrifugal force generated by the revolving weights of the governor when the speed of the fly-wheel changes, causes a change in the relative positions of the center of the eccentric and the center of the shaft.

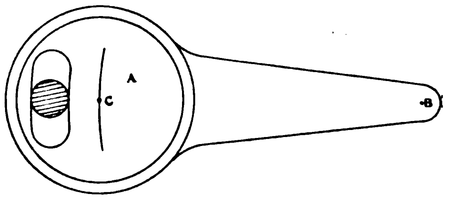

FIG. 3.

The movement of the eccentric center, due to a change in speed of the engine, may be arranged to take place along any one of three different paths, namely, (1) along a line curved toward the center of the shaft, as in Fig. 1; (2) along a straight line, as shown in Fig. 2, and (3) along a line curving away from the center of the shaft, as shown in Fig. 3. In the first case, when the eccentric is made to change its position, the lead will be increased, the path of the eccentric center being an arc curving toward the center of the shaft; in the second case, the path of the eccentric is a straight line running through the center of the eccentric and the center of the shaft, and the lead will be constant for all positions of the eccentric; when the path of the eccentric center is an arc which curves away from the center of the shaft, the lead decreases.

The character of the curve, toward or away from the center of the shaft, along which the center of the eccentric moves depends on the position of the point of suspension, *B*, of the eccentric arm. This will be readily seen by referring to Fig. 1 and Fig. 3. This refers to the more common methods of suspending the eccentric. The point of suspension, however, may be so located that it will cause the movement of the eccentric center to take place along paths varying greatly from those shown in Figs. 1, 2 and 3. For example, the suspension may be so arranged as to give equal leads for the maximum and minimum throw of the eccentric. Where the lead changes with the throw of the eccentric the nature of the change, whether it increases or decreases the lead, depends not only upon the direction in which the path of the eccentric center curves, but also upon the position of the point of suspension *B* of the eccentric arm.

A governor is required only where the load is variable, and is not necessary where the resistance is constant, such as in marine and hoisting engines. But when an engine is used to drive machinery which must be operated at as nearly constant speed as possible, such as spinning and electrical machines, the engine must be fitted with a governor, and one that will give close regulation. In this case the fly-wheel plays an important part, for while it is the duty of the governor to adjust the effort of the engine to any large or permanent variation of the load, such as would be caused by throwing the machinery in or out of gear, it is the duty of the fly-wheel, on the other hand, to adjust the effort of the engine to sudden fluctuations of load resistance that may occur during a single stroke of the engine.

As is well known, after the point of cut-off is reached the shaft type of governor has no control over the engine during the remainder of the stroke, so that if the load were suddenly increased between the point of cut-off and the end of the stroke, the engine speed would be greatly affected if there were no fly-wheel. In such a case the inertia of the fly-wheel would keep the engine running until the governor could act on the return stroke and cause the cut-off to occur later, thereby admitting more steam. If, on the other hand, the load were decreased after the point of cut-off, the fly-wheel would keep the engine running steadily, because by the time the inertia of the fly-wheel is overcome the governor will have had time to act, making the cut-off occur earlier in the stroke and thereby decreasing the amount of steam admitted to the cylinder.

It is also the duty of the fly-wheel to equalize the varying tangential effort on the crank-pin by storing energy while the piston is in the middle of the stroke, where the crank effort is greater than the resistance, and returning it when the crank is at the dead point, where the tangential effort is zero.

When regulation under load is considered, the high-speed engine has an advantage over a low-speed engine, for the reason that in a given time it makes many more revolutions, and, therefore, the change will be more gradual since the difference between each succeeding revolution is not so great as in a low-speed engine. For example, suppose the time required to affect a regulation is one second, then if one engine runs at the rate of 200 revolutions per minute, it makes 3⅓ revolutions per second. Now if the other engine makes 80 revolutions per minute, it will make 1⅓ revolutions per second. Therefore, the change per revolution in the high speed engine is much less than in the low speed engine, and the regulation is smoother.

Governors may be divided into two principal classes, namely, those that throttle the steam, and those that vary the point of cut-off. Each has its own advantages and disadvantages, some of which may be enumerated.

In the throttling governor, when the steam is forced through a small opening, it has the effect of superheating the steam and thereby reduces the loss by cylinder condensation. An engine using a throttling governor has no complicated valve gear and is, therefore, easier to build and cheaper to buy. The steam is admitted throughout a great portion of the stroke, which will cause the initial and final effort on the piston to be more equal. Some of the disadvantages of the engines using a throttling governor are: There is a greater loss of heat in the exhaust, due to the fact that the final pressure is comparatively high and consequently the exhaust steam will have a higher temperature; the governor is not as sensitive, so that it does not regulate as closely as the variable cut-off governor.

On the other hand, the variable cut-off governor has the advantage of being more sensitive; just enough steam is admitted to the cylinder to do the work required in each stroke; there is increased expansion of steam and less loss of heat in the exhaust on account of the final pressure being lower. It is at a disadvantage because the complicated valve gear increases the first cost and makes it more liable to get out of order; the greater range between the initial and final pressures causes unequal strains and necessitates a larger fly-wheel.

In an engine in which the point of cut-off is regulated by the governing mechanism, the point at which the valve will cut off may be changed by changing the number of revolutions, or by changing the boiler pressure, as will be evident from the following:

When the cut-off is too early, if the boiler pressure be lowered the mean effective pressure will be lowered, and in order to maintain a constant horse-power, the point of cut-off will have to be made later in order to bring the mean effective pressure up to its original value. This change in the point of cut-off is accomplished automatically by the governing mechanism. Similarly, when the cut-off is too late, if the boiler pressure be increased, then the mean effective pressure will have to be decreased to maintain a constant horse-power, and this means making the point of cut-off somewhat earlier, which is accomplished by the governing mechanism. If the number of revolutions is decreased to remedy a too early cut-off, the horse-power is correspondingly decreased, and, in order that the engine may deliver its usual power, the governor shifts the point of cut-off to a later point in the stroke, thereby increasing the mean effective pressure and bringing the power of the engine up to its proper amount. In like manner, when the cut-off is too late and the number of revolutions is increased, the horse-power is increased, and, in order to maintain a constant output, the governing mechanism shifts the point of cut-off to a somewhat earlier point in the stroke, which decreases the mean effective pressure sufficiently to give the proper horse-power.

TELEPHONE ENGINEERING.

Protective Devices.

BY F. J. DOMMERQUE.

The protective devices used on telephone circuits are of three kinds: lightning arresters; strong current protectors, or fuses, and sneak current arresters, or heat coils. Lightning arresters are to protect against atmospheric electricity and high-tension currents; strong current protectors or fuses against currents from electric light, power and all circuits of moderate potential; heat coil against sneak currents, which are caused by leakage or poor and defective insulation and are very weak, but still strong enough to damage the very fine wire in the coils used in telephone apparatus; these currents are often referred to as stray currents.

When speaking of "lightning" in connection with lightning arresters, it is not the direct stroke of lightning that is meant, as there is hardly any chance left for a telephone line struck in that way to survive, even with the best protection; fortunately the direct striking of a pole line by a flash of lightning is a rare occurrence. It is electrostatic induction that interferes most with telephone lines. A heavily charged cloud forms with the earth a huge condenser, the intervening sheet of air forming the dielectric. The telephone line or system, insulated from the earth but near to it, will be charged inductively, and when finally the cloud becomes discharged abruptly by a flash of lightning the charge upon the telephone line is set free and tends to pass to earth suddenly. The discharge will follow the shortest path to ground, but it will not hesitate to jump across air-gaps in its flight. For instance, instead of following the convolutions of fine wire around a coil it would cut across from layer to layer. To prevent harm being done to cables, coils and other telephonic apparatus, a short path to ground is provided at such places where the discharge may enter the cable or the switchboard.

Present practice recognizes only one style of lightning arresters as safe, namely, two carbon blocks separated by a thin sheet of mica or silk, one of the blocks being connected to the line and the other one to ground. Carbon is the most suitable material because it does not melt, does not oxidize and is cheap. A metallic line requires two sets of carbon blocks, one set for each conductor. The mica sheet between the two carbons separates them about 0.0055 inch and will allow the passage of a discharge at a difference of potential of 350 volts between the plates. When the discharge comes to the carbon arrester it will follow the short path across the separator to ground rather than follow the long path offered by the wires in the cable to the exchange. Fig. 1 shows the carbon blocks and the mica separator. This separator is cut out to a U shape and inserted with the open side downward so as to let any carbon dust that may come off drop out. The figure also indicates how the blocks are put together. As shown the upper block is provided with a groove with which the spring engages that holds the arrester in place.

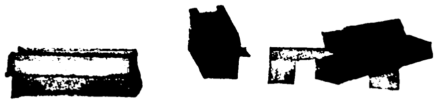

FIG. 1.—LIGHTNING ARRESTER PARTS.

The mounting of lightning arresters for terminals consists either of one spring holding the blocks against a ground bar or of two springs holding the blocks between them, in which case each block is grooved. The method of mounting lightning arresters upon the distributing frame at the exchange is a little more complicated, due to the use of a heat coil in conjunction with the lightning arrester, while at the terminal box a line fuse is combined with the lightning arrester instead of a heat coil. Metallic lightning arresters have been employed, but are not so reliable and, therefore, not recommended. Under this class comes the serrated plate arrester frequently found on telephone instruments. The function of the carbon lightning arrester in the first instance was to divert a lightning discharge from the line to the ground, but as the distance between the carbon blocks is adjusted by means of the mica separator for a difference of potential of 350 volts, high-tension circuits may also be taken care of. A street railway current of 500 volts, for instance, might also find a path to ground through the lightning arrester, but there is no certainty that it would. In any case, it is not safe to rely solely upon the carbon blocks.

A trolley current or an electric light current of moderate voltage would force a greater amount of current over the telephone line than it could stand, and the heating effects of such a current would be detrimental first of all to the lead cable, because the line wire enclosed as it is in the envelope of paper would quickly become hot enough to burn its insulation and the cable would soon be destroyed. In order to protect the cable in such a case, a fuse is inserted in each conductor that will open the line whenever a current of more than the carrying capacity of the fuse enters the cable. The size of the fuse depends on the size of the wire to be protected. With fine gauge wire such as is used in cables, a 2½-ampere fuse is recommended; with heavier wire, a 5-ampere fuse may be allowed. The fuse wire should be enclosed so as to prevent the arc from spreading to adjacent objects and also to prevent the fuse wire from scattering and setting fire to any inflammable material near it. The higher the tension of the current against which the fuse is to protect, the longer the fuse should be. A line fuse that meets present conditions fairly well consists of a piece of fine copper wire or a thin strip of lead enclosed in a fibre or wooden tube, the fuse wire being 4½ ins. long.

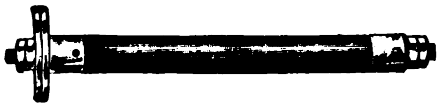

FIG. 2.—EARLY FORM OF FUSE.

In the earlier forms the ends of the fuse tube were provided with nuts, two at each end, to take the terminal springs between them, as shown by Fig. 2. In a latter form, shown by Fig. 3, a button terminal is provided at each end that engages the forked end of the terminal spring. The forms of tubular fuses shown by Figs. 2 and 4 have been used in some cases on lines that did not require lightning arresters. These kinds of fuses are inserted in the line either at the point where the drop wires enter the subscriber's house, or at the insulator upon the distributing pole. The clamp at the one end is attached to the line wire where it ends dead, while the bridle wire is held between the nuts at the other end. The fuse shown in Fig. 2 hangs vertically, while the one in Fig. 4 hangs horizontally in close proximity to the wire so as to be less liable to be caught by the lineman working upon the pole. Fig. 5 illustrates the two methods of attaching the fuses to the line wire.

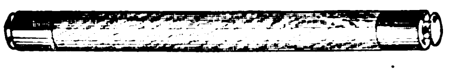

FIG. 3.—LATER FORM OF FUSE.

At the subscriber's station and at the telephone exchange, part of the apparatus contains such fine wire that a current that would pass the line fuse without blowing it would still be heavy enough to burn out that kind of apparatus. Therefore, at these two places a protector is required that takes care of the weak currents that may pass by the line fuses. At the exchange, heat coils are always provided with the lightning arresters, while at the subscriber's station a heat coil when required is mounted best upon one base with the lightning arrester and line fuse. If the line extends from the exchange in a cable to a distributing pole and then drops from this distributing pole in an insulated pair of wires direct to the subscriber's telephone, or contains only a short piece of open wire, the following arrangement is necessary and should be put in in this order, starting at the switchboard: Heat coil, lightning arrester, lead cable, cable terminal box without protection, drop wire to wall of house, line fuses where drop wires enter the house, interior wires to binding posts of instrument. When long open-line wires enter into the line between the cable and the subscriber's station, the following is the order of arrangement from the switchboard out: Heat coil and lightning arrester, lead cable, cable terminal box with lightning arrester and line fuse, open wire, drop wire, interior wire, lightning arrester, fuse and heat coil to the binding posts of the instrument.

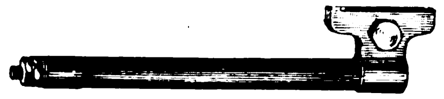

FIG. 4.—TELEPHONE LINE FUSE.

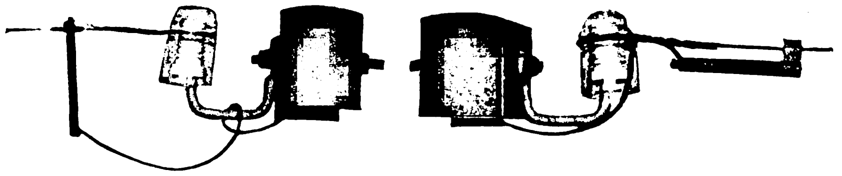

FIG. 5.—TWO METHODS OF ATTACHING FUSES TO LINE WIRES.

The best heat coil consits of a coil of German silver wire on a conducting shell surrounding a metallic pin to which it is soldered with an alloy of a low-temperature melting point, the whole being mounted in a hard rubber or fibre case and held upon a fork between a strong German silver spring and a ground plate at one end and supported by another spring at the other end. The outer spring is arranged so that when the coil becomes heated and the fusible metal melts, it pushes the entire coil down and forces the pin through the enveloping shell upon the ground bar. A heat coil of this kind and its mounting upon the main distributing board frame is shown in Fig. 6, the heat coil being also shown on an enlarged scale at the right. In another form of heat coil, when the fusible metal melts, the two springs spreads apart and pull the pin out of its enveloping shell or sleeve, the one spring making ground connection by means of a projecting pin, as shown in Fig. 7. As will be noticed from these illustrations, the lightning arrester and heat coils with their springs are mounted upon an iron bar which forms the ground bar of the main distributing board. In some cases an alarm devise is added which closes a battery circuit through an alarm bell whenever a heat coil goes, as a signal for the trouble man to replace the coil and re-close the circuit. There are so-called self-soldering heat coils on the market, but they should be carefully investigated as to their construction before buying, as it is not easy to construct a coil that will restore every time.

The specifications for heat coils vary according to whether they are to be used for common battery or for local battery systems. The specification for the heat coil in Fig. 6 for local battery is: Resistance 41.5 ohms of No. 37 B. & S. double silk-covered German silver wire, 36 inches long; the inner end soldered to the copper tube, the other end to the German silver washer; the coil to operate in less than 45 seconds with 0.16 ampere. For common battery: Resistance 5.25 ohms of No. 30 B. & S. double silk-covered German silver wire 23 inches long; the inner end soldered to the copper tube, the other end to the German silver washer; the coil to operate in less than 60 seconds with 0.4 ampere. Some specifications call for a larger fusing current, but reduce the time of operation.

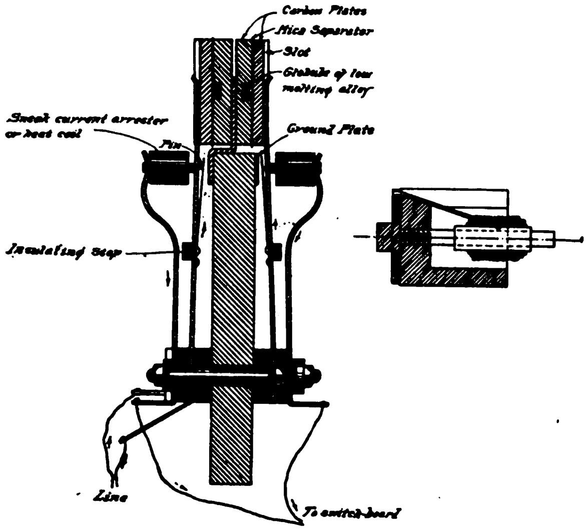

FIG. 6.—HEAT COIL PROTECTOR.

A well-designed combination of lightning arrester, line fuse and heat coil for subscribers' stations is illustrated in Fig. 8. The carbon blocks and heat coils are covered by a glass case. Though it is not a decorative addition to a room to have such a large protective device mounted above the telephone, this arrangement is more convenient than having a corrponding device mounted outside on the wall where the wires enter the house, because the protector is more accessible inside the building for cleaning and a blown-out fuse or coil can be more easily detected than when the apparatus is out of sight. On the other hand, a ground connection must be provided for the lightning arrester, and this may be easier to obtain on the outside of the building, though a water pipe is usually to be found handy on the inside. As mentioned before, however, in cities lightning arresters at subscribers' stations are nowadays exceptions rather than the rule, because cable has taken the place of aerial lines.

In late years rural telephone service has been developed to a great extent. The so-called farmers' lines are, of course, very long open wires greatly exposed to atmospheric discharges and therefore should be provided with lightning arresters. Simultaneous with the development of rural telephone service, the interurban electric railways have erected net-works of wires over the country and not only are 500-volt trolley circuits encountered but in many instances feeders at very high tensions are strung along the right of way. It is not always possible to keep the telephone lines away from these railway lines and often it is necessary even to cross trolley wires and high-tension feeders. In such cases the telephone wires should be insulated and in addition, insulated guard wires should be spanned under the telephone wires so as to prevent the telephone wires, should they ever break, from coming in contact with the trolley or high-tension wires. Wherever telephones are connected to open lines that cross such railways, the instruments should be protected by lightning arresters, line fuses and heat coils. The fuses to be used should be as long as possible; the fuses of to-day are in reality too short for such conditions and with further expansion of interurban electric railways a longer fuse is sure to come.

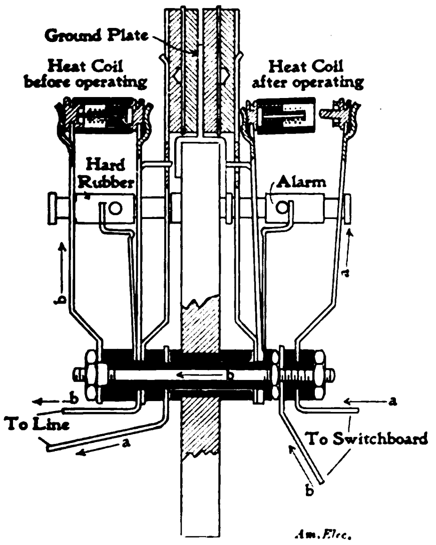

FIG. 7.—HEAT COIL PROTECTOR.

On farmers' lines that never come in close proximity to electric lines, a fuse and heat coil are very often omitted and a less expensive lightning arrester used which consists of carbon discs separated by mica, as illustrated in Fig. 9. However, such practice is not to be recommended. If it costs too much to put in proper protection in the shape of a carbon arrester, fuse and heat coil, a switch should be inserted between the line and the telephone, and this switch kept open during a thunderstorm.

The proper protection of toll lines is a very difficult problem. Some telephone men contend that it is not economical to have protectors at all at toll stations, but to risk the burning out of a coil (which they claim does not happen so often anyway) rather than to look after the arresters and keep them in working order. It seems practicable, however, to train the toll station agent and also the farmer sufficiently to enable them to take care of the arresters, fuses and heat coils, giving them sufficient reserve stocks of fuses and heat coils to draw from. A combination lightning arrester, line fuse and heat coil such as that illustrated by Fig. 8 costs from 75 cents to one dollar and is a good investment on exposed open-wire lines.

The protectors shown by Figs. 6 and 7 are used upon distributing boards in exchanges. This method of mounting the arresters upon an iron ground bar is always used in connection with multiple switchboards where the cables from the outside terminate in pot-heads. To terminate the outside cables in cable-heads and mount the protective devices upon these cable-heads, which are fastened to a separate frame and connected to the main distributing board by switchboard cables, does not conform to modern practice. In consideration of the fact that a distributing board with lightning arresters and heat coils of the design shown in Figs. 6 and 7 is rather expensive for small non-multiple switchboards, it has become the custom to construct a cheap distributing frame, consisting of a board to which the lightning arresters and ¼-ampere open fuses are screwed by means of wood screws and washers. In this respect, it may be said once for all that saving on protective devices is false economy; the best on the market is none too good even for the smallest installation.

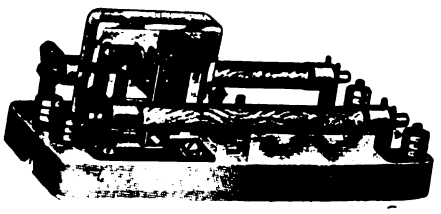

FIG. 8.—COMBINED LIGHTING ARRESTER, FUSE AND HEAT COIL.

As stated before, city lines are not much exposed to the influences of lightning, being surrounded by high buildings and other objects that form mediums for carrying the lightning discharges to earth, while toll and cross-country lines are practically without exception exposed over their entire length. Such lines are liable to be struck by direct lightning discharges from clouds, but the attempts that have been made to protect such lines have been successful to a great extent whenever the protection has been applied at the proper place. In open flat countries every tenth pole has been provided with a simple guard wire of iron; this wire being stapled to the side of the pole from top to bottom before setting, leaving a few inches of the wire extending above the top of the pole and bending the other end of the wire under the butt or coiling it around the butt, so as to provide a good ground connection. Preferable to this is the provision of ground-wire branches attached just below the cross-arm,

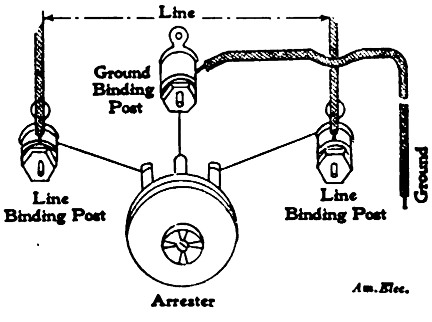

FIG. 9.—LIGHTNING ARRESTER.

or below the top cross-arm if there are more than one, these branch wires leading along the cross-arm and each terminating with a short rectangular bend under each of the line wires, leaving an air-gap of about half an inch. All these wire points will combine in drawing the discharge off to ground.

In hilly districts this kind of protection when applied at regular intervals may leave the most exposed poles unprotected; therefore, under such conditions the protection should be placed upon all the exposed poles, even if they are close together, while the sheltered poles may be left without. The method just described is the simplest one. Construction men have varied the method to suit their fancies, but the principle remains the same.

PIPE THAWING BY ELECTRICITY.

BY CHARLES H. PETERS.

The recent appearance in electrical journals of one or two articles on this subject has undoubtedly awakened many central station managers to the advantage of being equipped for this class of work when cold weather sets in. After a winter of active service, the writer takes pleasure in describing an equipment used by The Durango Light and Power Company, Durango, Colo., which has given excellent satisfaction.

Owing to an unusually light snow fall, the ground was frozen in places to a depth of four feet, and as digging is almost impossible under such conditions owing to large granite boulders underlying the surface, the "ambulance" was constantly in demand for nearly a month. The accompanying engraving gives a fair idea of its construction. There is no water rheostat; everything is ready at a moment's notice for action. The advantage of being able to do away with water when hurrying from one point to another is apparent. In the wagon box are placed four Westinghouse transformers with 55-volt secondaries, such as were used here several years ago, but have been replaced with the oil type of higher secondary voltage; by using these, old stock was made to earn good money. It will be noticed that the wagon box has a removable top several inches deep; this carries the rest of the equipment.

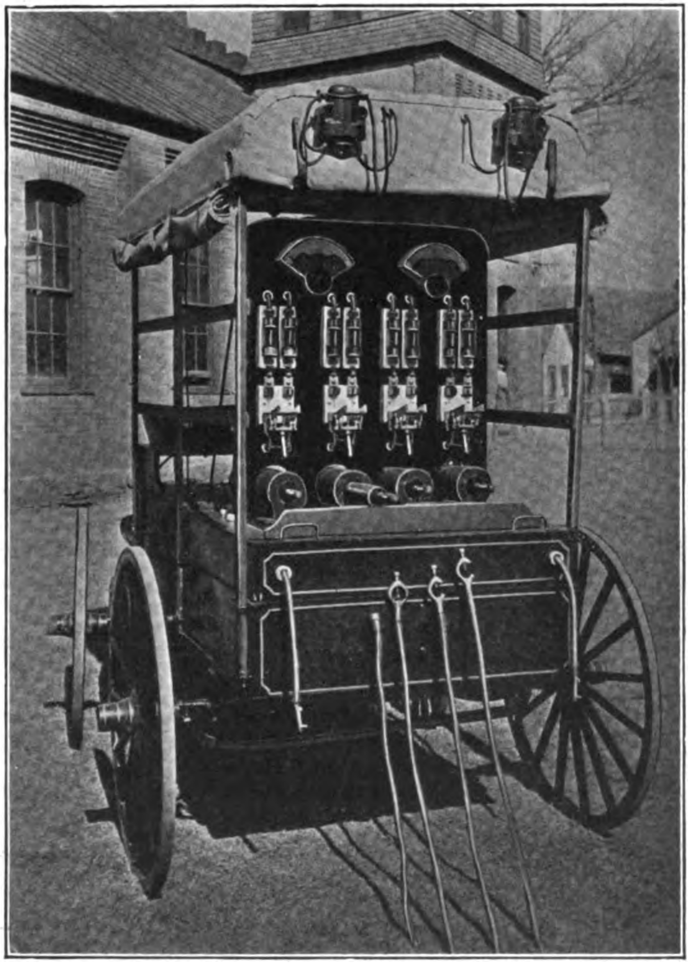

FIG. I.—PIPE THAWING EQUIPMENT.

At the bottom of the switchboard are four reactive coils, used to regulate the secondary voltage of each transformer. These are each 18 inches long, and the tube into which the core slides is 2½ inches inside diameter. The ends are brass castings, and a slot was cut lengthwise through the tube and ends to prevent the formation of a closed secondary circuit. After being well insulated, each tube was mounted on a wooden mandrel exactly fitting the bore, to prevent the edges at the slot from being squeezed together, and wound with two layers of No. 4 d. c. c. magnet wire (four layers were tried first, but two layers were found to be better). This winding was coated with insulating varnish, and after drying, covered with extra heavy insulating paper to prevent abrasion. The cores are each 18 inches long and composed of 500 No. 14 annealed iron wires, carefully straightened and assembled around a central soft-iron rod which is threaded at each end and carries two fibre heads turned to fit the tube easily. Before these heads were put on, the iron wires and rod were forced into a short piece of 2-inch iron pipe to hold them firmly together. One fibre head was then slipped on and tape wrapped over it and the iron wires as they were withdrawn from the pipe. The other fibre head was then slipped on, taped over, and the two heads clamped against the ends of the wires by a handle screwed on to one end of the rod and a nut on the other. Next, a layer of cotton tape was applied and coated with baking varnish.

Above the choking coils, on the switchboard, are four 75-ampere double-pole knife switches, eight 100-ampere single-pole D. & W. cartridge fuses, one 350-ampere ammeter, one 150-volt voltmeter, and four small lamps, the sockets of which are shown over the top edge of the board in the picture; each of these lamps shows when the corresponding transformer is active. On the back of the wagon covering are two G. E. transformer type 30-ampere primary cut-outs, and back of these, just inside, is a 30-ampere double-pole 500-volt quick-break knife switch, to open the primary circuit, which it does successfully; the primary e.m.f. is 1100 volts. Entering through porcelain tubes in the tailboard of the wagon will be seen the No. 00 cable leads with connectors attached, and between these stand the No. 0 cable connections for rapid attachment. The one on the left of the group is for connecting to the ordinary street washer box; the next one is for the valve screw of fire hydrants; the third and fourth are for connecting to common water faucets and ¾-inch pipe. On the other end of each of these is a straight connector for taking No. 0 wire; the cables to the primary cut-outs are also furnished with straight connectors, to take No. 8 wire.

For quick work, three men form the crew of this pipe-thawing machine. Arriving upon the scene, one man climbs the nearest pole and attaches the primary wires, which he has previously connected to the cut-outs. The other men take each a coil of No. 1 wire and roll it out to the faucets, or points where connections are to be made for thawing; they then connect the other ends to the leads on the wagon. The primary and secondary switches are then closed, and the cores are pulled out of the choking coils until the desired amount of current is obtained for the service under treatment. All service pipes here are iron, and generally speaking, extend from 75 to 100 feet from the main. For this length of ¾-inch pipe, we use 135 amperes, and water usually flows in from five to ten minutes. The chief reason for not using more current is to avoid any possibility of damaging the lead connection which is often used where the service pipe comes from the main; another reason is that it avoids too sudden a rise in the temperature of the pipe joints. If water does not flow in from eight to ten minutes, the current is increased slightly, but it is seldom over 15 amperes for this class of work.

On one occasion, this apparatus thawed out over 700 feet of 1-inch pipe, on which were five houses; it was frozen solid. One wire was attached to the farthest house and the other to a fire hydrant near where the pipe was tapped to the main. In this case, 175 amperes were applied, and water was running at all the houses in twenty minutes. A second case was the thawing of nearly 1500 feet of 4-inch cast-iron pipe. This was thawed in sections, starting at the main. On account of the working connections being made to service pipes, the current was limited to 250 amperes; the entire length was clear in three hours.

For thawing an ordinary service pipe, the charge is five dollars, and we often thaw two at once, so it can readily be seen that this field, as a source of revenue, is worth developing. Our observations are that a buried pipe rarely bursts until it has been frozen for over twelve hours, and less than 10 per cent of them burst at all; therefore, if people notify us promptly, the pipes are usually thawed before the ice has expanded sufficiently to cause any damage. As the cost of digging up an ordinary service pipe here in winter is about fifty dollars, the benefits derived from electric pipe thawing are mutual.

The writer wishes to acknowledge valuable aid given him in the construction of the thawing outfit by his assistant, Matt Harrington, and the company's first engineer, S. B. Richey.

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THE ZEUNER VALVE DIAGRAM.

BY C. C. MAJOR.

In a previous article, the relative positions of the valve, piston, crank and eccentric were shown by drawing these parts in their proper positions, under assumed conditions for the different events of the stroke. A clear understanding of these relations is necessary before the subject of valve setting can be thoroughly understood; but there are other questions which come up in connection with the subject of valve gears, and these can best be studied by means of the "valve diagram."

When an engine is to be designed, the steam distribution is assumed and the dimensions and movements of the valve determined to give the desired results; while on the other hand, the operator or engineer wishes to know the steam distribution after the dimensions and movements of the valve are fixed. The indicator card, when we learn to interpret it correctly, tells us many things about the operation of the valve and when the different events occur, but for a complete analysis of the subject, the valve diagram is indispensable.

There are many valve diagrams used for solving problems relating to valve gears, and no doubt each has its special advantages. The Zeuner diagram is simple and yet is comprehensive enough to analyze the movements of practically all ordinary valves such as the slide valve, Meyer valve, link motion, etc. By means of this diagram, the angles which the crank makes with the horizontal and the corresponding piston positions may be readily shown for all the events of the stroke; also, the travel of the valve from its mid position and the amount of steam and exhaust port opening for any piston and crank position.

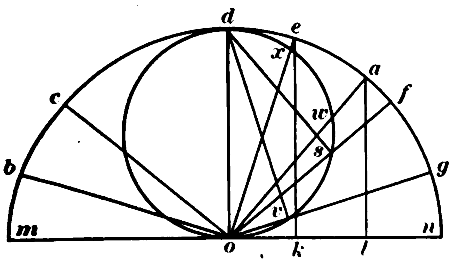

FIG. I.

If the valve is without lap, as illustrated in a previous article, the crank and eccentric will be at right angles to each other. In Fig. 1, let *o—m* represent the crank on the dead center and *o—d* the corresponding position of the eccentric. The length *o—d* should be made equal to the eccentricity *r*, Fig. 2, which is the distance between the center of the shaft and the center of the eccentric. As the crank moves to the positions *o—b* and *o—c*, Fig. 1, the eccentric will occupy the corresponding positions *o—c* and *o—a*. If from the points *e* and *a*, the perpendiculars *e—k* and *a—l* are let fall upon the diameter *m—n*, the distances *o—k* and *o—l* will represent the travel of the valve from its mid position for the positions *o—e* and *o—a* of the eccentric.

The travel of the valve for any crank position may also be shown by drawing perpendiculars from *d* to imaginary crank positions on one side of the center corresponding to the actual positions on the other side. Then the travel of the valve is the distance from *o* to the foot of the perpendicular on the assumed crank position. For the crank positions *o—b* and *o—c*, draw the lines *o—g* and *o—f*, and let fall the perpendiculars *d—v* and *d—s* to these lines; then the movement of the valve for the crank positions *o—b* and *o—c* will be respectively *o—v* and *o—s*. It was shown that the valve travel for the above positions of the crank is respectively *o—k* and *o—l*, but it can be proved by geometry that *o—v* is equal to *o—k*, and *o—s* to *o—l*.

When a circle is drawn on the hypothenuse of a right angle triangle as a base, the apex of the triangle will lie in the circumference of the circle, consequently, the locus of all the points obtained by dropping perpendiculars from *d* to the different crank position will be a circle drawn on *o—d* as a diameter. Then the valve travel for any position of the crank is the chord of the arc intercepted by the crank. When the crank occupies the positions *o—g*, *o—f*, *o—a* and *o—e*, the corresponding valve travels are *o—v*, *o—s*, *o—w* and *o—x*.

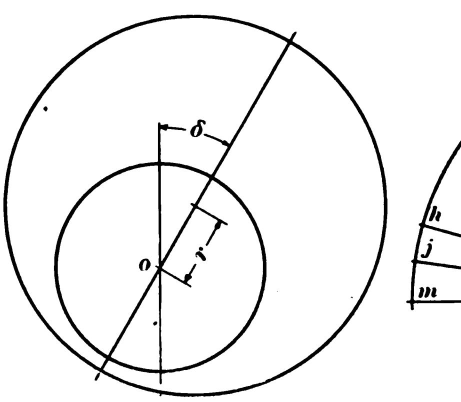

FIG. 2.

When on the dead centers *o—n*, the crank does not cut the circle, consequently, the valve is in its mid position and the ports are covered. When the crank-pin moves from the position *o—n*, it will cut the circle and the valve will have traveled a distance corresponding to the angular movement of the crank, and will evidently remain open until the crank reaches the opposite dead center *o—m*. Steam will enter the cylinder during the entire stroke and its expansive force will not be utilized.

To draw the diagram when the valve has steam and exhaust lap:—In Fig. 3, *s* is the steam lap; *i*, the exhaust lap; *p*, the width of the steam ports; *b*, the width of the bridge, and *e* that of the exhaust port. In Fig. 2, *r* is the eccentricity of the eccentric and δ the angular advance. Let *o—m* and *o—n*, Fig. 4, represent the dead centers of the crank, and *o—p* the center line of the eccentric when the valve is in its mid position. Make the angle δ equal to the angular advance of the eccentric. Take *o—c* equal to the eccentricity, *r*, of the eccentric, and on *o—c* as a diameter, draw the valve circle *o—d—c—b*. About the center, *o*, with the radius *o—w* equal to the steam lap *s*, Fig. 3, draw the lap arc *d—w—e* cutting the valve circle at *d* and *e*; and with the radius *o—v* equal to the exhaust lap *i*, Fig. 3, draw the exhaust lap arc *l—v—k*, cutting the valve circle at *l* and *k*.

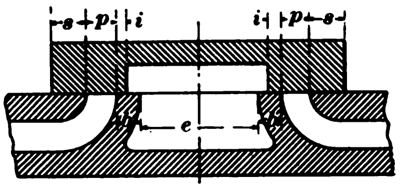

FIG. 3.

The distance *o—c* represents the extreme movement of the valve from its mid position in either direction. Since *o—w* is the distance the valve extends beyond the port, the valve must move this distance to bring its edge in line with the port; so that *w—c* is the maximum amount of port opening, providing the valve does not travel beyond the inside edge of the port.

When the crank is in the position *o—s*, the valve has moved from its mid position the distance *o—e*, and is about to open the port to the admission of steam; consequently, *s* is the point of admission. When the crank has reached the dead center *o—n*, which is here assumed to be nearest the cylinder, the valve has moved to *b* and the steam port is open the distance *a—b*, the amount of lead. At the same time the exhaust port in the crank end is open the distance *i—b*, the amount of exhaust lead. As the crank turns in the direction indicated by the arrow, the port

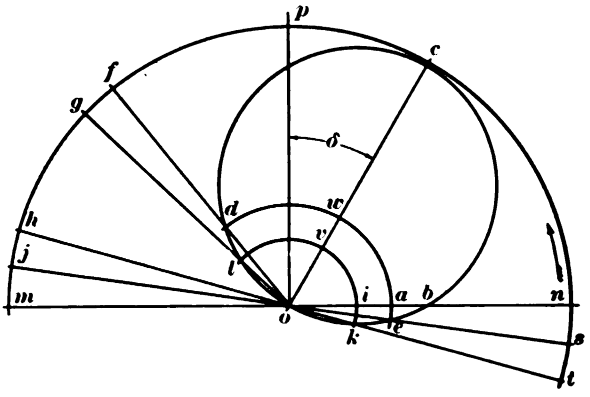

FIG. 4.

opening increases until the position *o—c* is reached, giving the maximum steam and exhaust port opening. Beyond *o—c* the port opening decreases and when the crank is at *f* the valve is just closing the port; hence, *f* is the point of cut-off.

As the crank reaches *o—g*, the exhaust port in the crank end closes and *g* is the point of compression for the crank end. At *o—h* (or *o—k* prolonged backward) the exhaust opens in the head end and *h* is the point of release. When the crank reaches *o—j*, or *o—e* prolonged backward, admission occurs in the crank end.

It will be noticed that the line representing the center of the eccentric is drawn in the first quarter of the circle when the crank is at the dead center *o—n*. This is not the true position of the eccentric, but it is the usual position in drawing the Zeuner diagram.

Separate diagrams, as shown in Fig. 5, may be drawn for each end of the cylinder. The circle *m—p—n* represents the path of the crank, *o—m* and *o—n* being the dead centers; *o—c* is the eccentricity *r* of the valve and δ the angle of advance, *d—w—e* is the steam lap arc and *l—v—k* the exhaust lap arc. The valve circles *d—c—e* and *l—u—k* are drawn on *o—c* and *o—u* as diameters, each being equal to *r*.

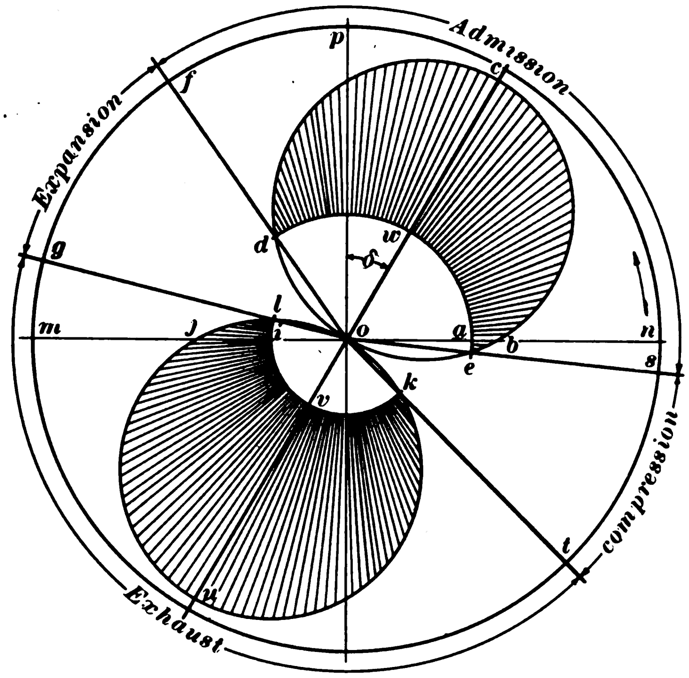

FIG. 5.

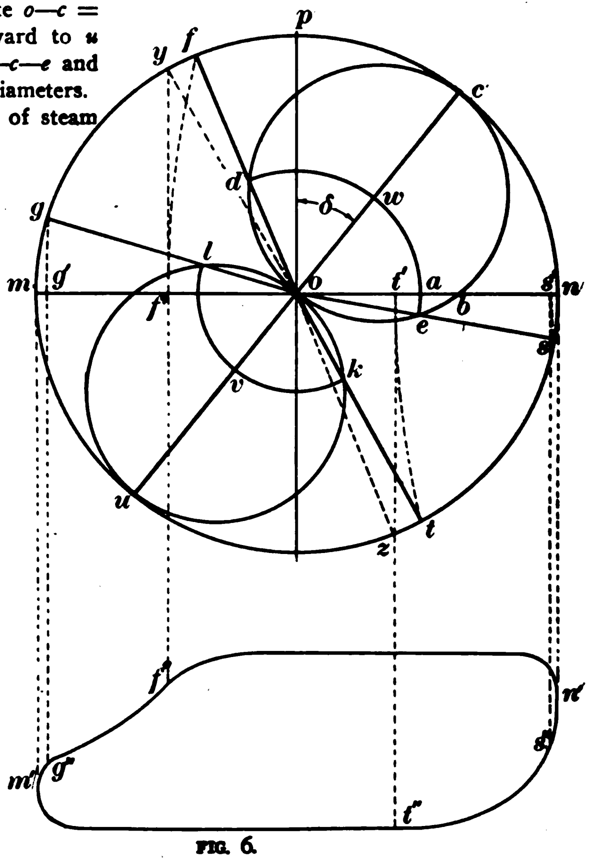

FIG. 6.

When the crank is at the dead center *o—n*, the valve is open the distance *a—b*, which is the amount of lead. At *f* the valve closes, the radial lines in the shaded portion of the circle *o—d—c—e* representing the amount of port opening as the crank-pin travels from *n* to *f*. The expansive force of the steam is being utilized in driving the piston while the crank travels from *f* to *g*. Release occurs at *g* and steam is exhausted from the cylinder during the movement of the crank from *g* to *t*, the radial lines from the arc *l—v—k* to the arc *l—u—k* showing the varying amount of port opening till exhaust closure occurs when the crank is at *t*. Compression occurs during the crank travel from *t* to *s*, the point of admission.

While these events are occurring in one end of the cylinder, complementary events are taking place in the other end, and it is not necessary to draw the diagram for both ends except for special purposes.

To draw the valve diagram and approximate indicator diagram when cut-off is to occur at three-quarter stroke, release at 98 per cent, and compression at 99 per cent of the return stroke:—Suppose the eccentricity *r* of the valve to be 2¼ inches and the connecting rod four times the length of the crank. Lay off *n—f'*, Fig. 6, as three-quarters of *n—m*, and with a radius equal to four times the length *o—n*, draw the arc *f' f*; *f* is the position of the crank-pin for the required cut-off. Take *m—s'* equal to 99 per cent of *m—n* and with a radius equal to 4 times *o—n*, describe the arc *s'—s*. Draw *o—s* which is the crank position for compression. Bisect the angle *f—o—s* by the line *o—c* and make *o—c* = 2¼ inches. Prolong *o—c* backward to *u* and draw the valve circles *o—d—c—e* and *o—l—u—k* on *o—c* and *o—u* as diameters.

The chord *o—d* is the amount of steam lap, which is equal to 1 1-16 inches. With *o—d* as the radius, draw the lap arc *d—w—e*; then the amount of lead *a—b* is about ¼ inch. The point of release is obtained by making *n—g'* equal to 98 per cent of *n—m* and drawing the arc *g'—g*, as before; then *g* is the point of release. The exhaust lap is the chord *o—l*, practically ⅞ inch. By drawing the lap arc *l—v—k* and drawing the line *o—t* through the point *k*, the point of compression is obtained.

The indicator diagram may be constructed by drawing the admission and exhaust steam lines and projecting the points *n*, *f'*, *g'*, *m*, *t'* and *s'* to *n'*, *f''*, *g''*, *m'*, *t''* and *s''*. The distance between the admission and exhaust steam lines depends entirely upon the pressure of the steam supplied to the engine and the back pressure.

The effect of the angularity of the connecting-rod may be noticed in this diagram. When the piston has traveled three-quarters of its stroke, from *n* to *f'*, the crank-pin is at *f*; but if the connecting-rod were of infinite length, the crank-pin would be at *y* and the crank position would be *o—y* instead of *o—f*. A similar effect may be noticed on the return stroke.

An inspection of Fig. 7 will show the effect of making cut-off occur at equal periods in each stroke. Suppose cut-off takes place at three-quarter stroke, or at *r* in the forward stroke and at *t* on the return stroke. When the piston is at *r*, the crank is at *f*, and assuming admission to occur at *s* in the head end, the center of the eccentric is along *o—c*. Extend *o—c* backward to *c'* and draw the valve circles as before. The chord *o—d* from *o* to the point where the valve circle meets the crank at the cut-off position is the steam lap for the head end of the valve, and, by drawing the lap arc, *d—w—e*, lead *a—b* is obtained for the head end. The lap for the crank end is the chord *o—d'*, which is considerably shorter than the lap for the head end. By drawing the crank end lap arc with the radius *o—d'*, the point of admission *s'* may be found by drawing *o—s'* through the point *e'*. It is evident that admission occurs earlier in the crank end than in the head end, and the lead *a'—b'* is considerably greater than the lead *a—b*. Hence, the effect of equalizing cut-off by giving the valve a greater amount of lap on one end than on the other is to make the lead unequal and to cause admission to occur earlier in the crank end. The effect of the angularity of the connecting-rod cannot be entirely eliminated without the aid of special links, as any change made to equalize one event will make other events unequal.

In the design of a valve gear, certain constants are assumed and others are found by drawing the valve diagram. The constants are s and i, Fig. 3, δ, r, the lead, and the crank positions at admission, cut-off, release and compression. The first four constants may be assumed, but only three of the crank positions can be taken and the fourth is found from the diagram. The valve may have overtravel, but r must be less than the sum of $s + p + b$, Fig. 3, or live steam will flow directly into the exhaust port; and the exhaust port e must be wide enough to that when the valve is at its extreme travel, the exhaust opening will be at least equal to the steam port p.

Suppose the crank positions at cut-off and compression, the angle of advance δ and the eccentricity r, are assumed; to find the points of admission and release and the amount of steam and exhaust lap and lead, one proceeds as follows: Draw the crank circle m—p—n, Fig. 5, and lay off the angle c—o—$p = \delta$. Extend o—c backward to u, making o—c and o—u each equal to r. On o—c and o—u as diameters, draw the valve circles. Draw the lines o—f and o—t for the given crank positions, and with o—d and o—h as radii draw the lap arcs; then the crank positions o—s and o—g for admission and release may be drawn. The steam lap will be the distance a—b and the exhaust lap i—j.

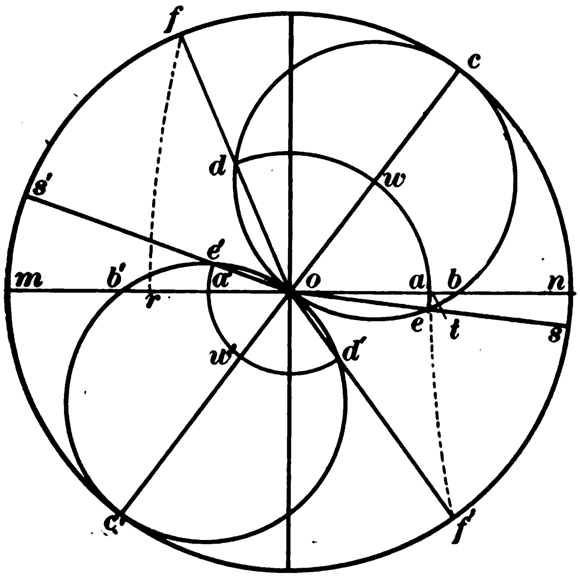

FIG. 7.

Given the crank position at release, the steam lap, the lead, and the eccentricity r, to find the remaining constants and crank positions:—With the given lap as radius, draw the lap arc d—w—e, Fig. 5, and make a—b equal to the lead. With r as radius, draw a circle about the center o and erect a perpendicular from b to meet the crank circle at c; then o—c is the diameter of the valve circle, which fixes the position of that circle. The crank positions for cut-off and release may now be drawn. The exhaust valve circle may be drawn as before and by drawing the given crank position o—g, the lap arc and crank position for compression are easily obtained. Other problems may be similarly solved.

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STORAGE BATTERY EXHIBIT AT ST. LOUIS.

BY CLOYD MARSHALL.

Storage batteries will have a more conspicuous place in the electrical exhibits at St. Louis than in any previous exposition, because the use of batteries has extended into every branch of the industry. Besides the displays of the storage battery companies, installations will be made in the several telephone exhibits, in the laboratory of the National Bureau of Standardization, and in some of the lighting and generator exhibits. The principal installation of storage batteries showing their various applications is now being made in the Southwest corner of the Electrical Building.

The Electric Storage Battery Company will have a space in Section 20, and will have a working battery regulating on a changing load to show exactly what results can be obtained from the use of a battery in railway or other fluctuating work. This battery will be installed in a model battery house, constructed on exactly the same lines as a regular battery house, forming part of a power house or sub-station equipment. The battery house will be of fire-proof and acid-proof construction, properly ventilated and with acid-proof brick floor. A small booster will be operated in connection with this battery, and a complete switchboard will be installed with recording instruments to show what work the battery is doing on the fluctuating load, and also how constant the load is maintained on the generator.

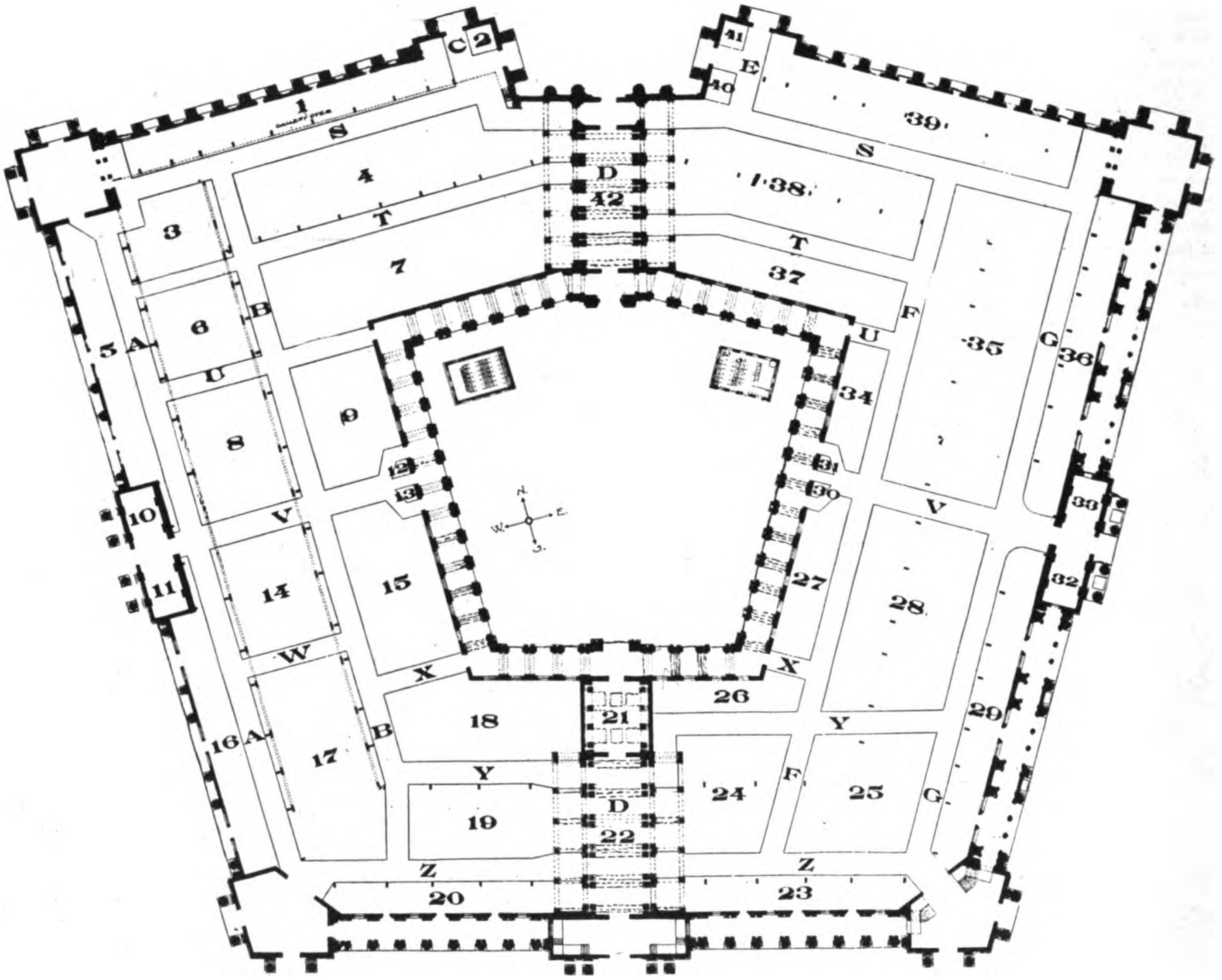
The fluctuating load will be provided either by switching on or off banks of lamps, or starting up a motor load with brake attached. A railway booster of about 100 kilowatts complete with switchboard and regulator will be shown, the motor being connected so that the machine can be run light; a complete line of switchboards for Edison work, isolated plants, railway booster equipment and line batteries; a set of three motor-driven end-cell switches connected up complete with motor control and indicator apparatus, such as is used in Edison work; complete cells erected of type "H" for lighting service; complete "G" type cells for railway work, such as are installed for the St. Louis Transit Company; complete cells of smaller type, set up to show the various types and capacities. A complete exhibit of vehicle batteries for automobile and locomotive work will be shown as well as a collection of photographs and curves showing existing plants and results obtained by same.

On the wall space at the back of the exhibit will be a large map of the United States, approximately forty feet by twenty-five feet, which will indicate the location of each of the electric battery installations, amounting to some 1600 or 1700. These will be shown by a different colored spot of isinglass about one inch in diameter, which will be illuminated by incandescent lamps mounted behind the map, the different colors being as follows: Red lamps for railway plants; blue lamps for Edison plants, white lamps for telephone and telegraph plants and green lamps for isolated plants.

The Gould Storage Battery Company and the Gould Coupler Company are preparing a complete exhibit in Section 16, showing the various adaptations of storage batteries to engineering work. It contains a battery of 60 Gould accumulators, type "O," No. 515 in lead lined, glass-covered tanks. The cells will be mounted in two rows of two tiers on a suitable rack of angle iron or wood. An induction motor is coupled to a double generator or rotary transformer. The purpose of this combination is to use the induction motor to drive the rotary transformer as a direct-current generator, charging the batteries in connection with a booster set. This represents a direct-current power station operating with a regulating battery in connection with a booster set; also, when the induction motor is disconnected, to operate the rotary transformer to represent a rotary sub-station in connection with battery and booster set; also to drive the rotary from the induction motor as a direct-current generator in which the series winding would be reversed to demonstrate a station with constant output (in wattage) in connection with the battery, the batteries taking all the fluctuations below and above a predetermined average, independent of any booster; also to drive the rotary from the induction motor as a direct-connected generator to demonstrate the train lighting system in connection with a suitable motor-driven counter e.m.f. booster, of the railroad type "G."

A booster set is being installed which is to demonstrate a power station regulation within 2 per cent above or below a predetermined average in connection with the battery, and for demonstrating a booster set operating with battery to show an equally close regulation operating with the rotary transformer disconnected from the induction motor as a rotary sub-station. By slight alterations in the connections, it represents an exciter booster system. With the combination of storage battery, motor-generator and booster set and a variable load on an artificial consumption circuit, a very close booster regulation will be obtained. Upon a switchboard about fourteen feet long will be mounted the various instruments, switches, etc., necessary for handling and manipulating the regulating system mentioned above.

A unipolar generator will drive a direct-current motor, taking its current from the bus-bars to which are connected the batteries in series with the booster set. The unipolar generator will be used to charge the two "U" type cells shown in the same group at from 3000 to 5000 amperes. By a suitable change in the connections, the two powerful "U" type cells will be discharged through the unipolar generator operating it thus as a motor to drive the direct-current motor as a generator to charge the battery set, after the battery is once thoroughly developed and charged to illustrate its working capacity and the close regulation obtained by the booster set in charging the two big "U" cells through the motor-driven unipolar machine and to illustrate the large capacity of the "U" cell in charging the battery through the unipolar machine and its motor run as a generator, thus illustrating the conservation of energy principle, the losses in translating apparatus being made up by an occasional charge from the motor generator set. A motor-driven direct-connected generator will be utilized in showing some other regulating systems in connection with the battery.



INSTALLATION PLAN FOR ELECTRICITY AND MACHINERY, ST. LOUIS EXPOSITION.

A new Gould counter e.m.f. booster is encased in a dust-proof, water-tight compact form for railroad train lighting work. It will operate in conjunction with either the first or second motor-generator set and railroad batteries to be located in the Gould Coupler Company's exhibit, which is installed just south of the Gould Storage Battery Company. The train lighting system is one in which the load on the generator will be kept constant by the automatic distribution of its output, through the medium of the counter e.m.f. booster, to the electric lights and the batteries, according to requirements. If the number of lights burning requires the total energy of the generator, the batteries will receive no charge. If the number of the lights burning is equal only to one-half the capacity of the generator, the remaining capacity of the generator will go into the batteries, the voltage of the generator remaining constant, the booster set automatically furnishing what additional voltage is necessary to charge the batteries, subject, of course, to the amount of power which the generator can furnish to the batteries.

A model trolley road with one or two movable model trolley cars will be shown. There will be introduced sufficient resistant to make the model trolley road charge and discharge the battery according to the floating battery principle.

A group of four elements in lead lined tanks with glass covers is being installed. The largest cell will be the one exhibited at the Pan-American Exposition, which gave a discharge of 27,000 ampere hours at a 2000 ampere discharge rate. It was also discharged at the rate of over 30,000 amperes, which is the largest discharge rate on record.

The Porter Storage Battery Company will show its train lighting system in Section 20, and the Columbus Storage Battery Company will make a showing of small batteries.

In the Edison exhibit, Mr. Edison's new cell is to be demonstrated in a way which will add much to the valuable data already compiled from this type of cell.

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Dried-out Motors and Transformers.—An interesting and successful experiment has recently been carried out with a number of transformers and induction motors used in driving the pumps of the Knights Deep mine at Johannesburg, South Africa. During the war the mine became flooded, submerging 12 three-phase, 50-h.p. motors and 36 15-kw. transformers. Two years after, the water which covered the machinery to a depth of 500 to 1000 feet was pumped out and the apparatus removed to the surface. Three of the motors were rewound and the others were dried in an over and then soaked in oil. The transformers were dried out in the same manner and all put back in service.

Abstracts from Foreign Contemporaries

New Mercury-Vapor Lamp.—*The Electrician* of London describes a new form of mercury-vapor lamp, brought out by C. O. Bastian and A. E. Salisbury, possessing several features of novelty. Fig. 1 herewith shows the lamp in its normal position. *E* is a spun copper bell-shaped cover which protects the internal mechanism from wet, and provides a means for suspending the lamp and fixing the tubes and other devices. *G* is an ordinary glass globe. As shown in the illustration, the lamp is not at work and it will be observed that the mercury in the tube *T* connects together the two wires sealed into the glass. Fixed to one end of the glass tube is an iron plunger *C* which acts as a core to the electromagnet *M*. Now, it is obvious that if the switch were closed with merely the column of mercury in the circuit the only result would be to blow the fuse, and therefore the resistance *R*, the electromagnet *M*, the carbon filament lamp *L* and the mercury in the tube *T* are all connected in series. On closing the switch, the core *C* is drawn up by the electromagnet, *T* being pivotted at *P*, and the continuity of the mercury being broken, an arc is formed. It will thus be seen that the tilting of the tube is effected automatically instead of by hand, as in other forms. But the mere tilting is not sufficient to effect all that is necessary, for the resistance *R* has to be short-circuited, and this, again, is brought about automatically. To fill the left-hand bulb of the tube with mercury merely by tilting would be inexpedient, as the tube would have to be brought into a position approximating the vertical. Happily, the pressure of the mercury vapor set up by the arc forces the mercury up into this bulb, and thus cuts out the auxiliary resistance. All these operations occupy but a fraction of a second, and there is no "time-lag" in the starting of the lamp. A more or less successful attempt to overcome the absence of red rays has been made by fixing the carbon filament lamp *L* just above the mercury tube. This lamp is under-run and its radiation is consequently rich in the required red rays. The patentees claim an efficiency of 2½ candle power per watt when the carbon auxiliary is not used, and 1 to 1.5 candle power per watt when the latter is used. Each lamp requires from 40 to 60 volts and 0.65 ampere, and the candle power is said to be 80. Lamps have been run both continuously and intermittently for over 1,500 hours, and the inventors believe that the average life will be about 3000 hours. Although they hope that there will be a demand for the lamps for indoor lighting, the principal object is to provide an electric lamp for side street lighting which will compete successfully with incandescent gas lighting. The efficiency of the lamp is necessarily less than that of the Cooper Hewitt, but it has the advantage of a neater shape.

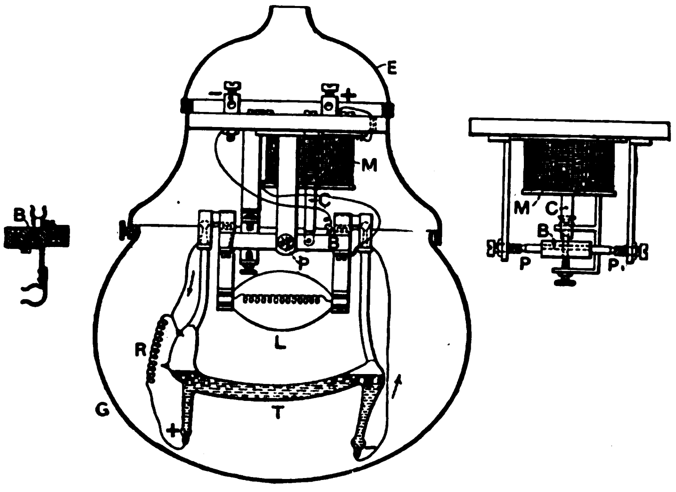

FIG. 1.—MERCURY-VAPOR LAMP.

Bradford Feed Pump.—Fig. 2 herewith shows a new type of boiler feed-pump recently introduced in England and described in London *Engineering*. As shown, the pump is of the direct double-acting type. The distribution of steam in the actuating cylinder is governed by a single valve, which is operated entirely by mechanical means, and which is therefore not liable to stick in the annoying manner that is sometimes experienced with pumps of this nature fitted with an ordinary shuttle-valve. The valve is operated on the "lost-motion" principle by means of a lever connected to the piston-rod as shown, the distribution of steam being indicated by the arrow. There are bored in the liner of the pump cylinder a number of small holes or ports. These are so arranged that when the steam valve reaches its central position, and the steam is cut off from entering the steam cylinder, these ports are beginning to open, owing to the upward or downward movement of the pump-piston. This opening of the ports throws both sides of the pump-piston into communication. The pressure on the pump-piston is therefore equalized, and the expansion of the steam in the steam cylinder is then sufficient to complete the full stroke, thereby actuating the steam-valve, so that steam is admitted to the opposite side of the steam cylinder. Naturally, as is common with this type of pump, the steam is carried practically full stroke, no more work being done by expansion than is required to complete the very small portion of the stroke necessary to operate the valve. The advantage of this design will be apparent, the pump acting with certainty, and a full stroke being obtained with every reciprocation. There is no fear of sticking at any speed and a very regular discharge is obtained owing to the absence of any slowing down at the end of the stroke. The steam valve is of a simple type. The pistons of the water-pump are packed with ebonite rings and all parts in contact with water are of gunmetal.

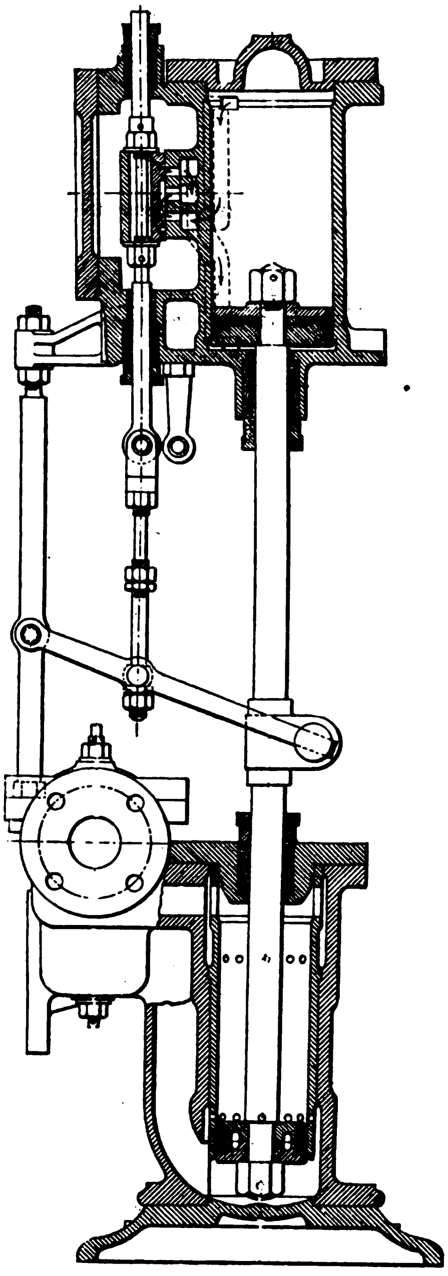

FIG. 2.—BRADFORD FEED PUMP.

Electrical Methods of Measuring Temperatures.—In the third and last of his lectures on the above subject at the Royal Institution, Prof. Callendar demonstrated the applicability of electrical methods for taking indicator diagrams. For this purpose a motor cycle had been rigged up in the lecture room, and five thermocouples had been screwed from the outside into the cylinder wall of its small internal combustion engine. Since the thickness of the cylinder casting is but about ⅛ in., the temperature indications of the thermocouples could be taken to represent also the internal temperatures. One couple was placed near the exhaust, another near the inlet, and the remaining three were fixed near the top, the middle and the bottom of the stroke respectively. First of all, Prof. Callendar determined the temperatures at these various points. He proved experimentally that the temperature at the exhaust side of the cylinder was considerably higher than at the inlet side, but that, by directing a blast of air from a small fan against the exhaust, this order of things might be reversed and the engine rendered more powerful in consequence. The measurement of the temperatures at the three points of the stroke brought out the interesting fact that these temperatures differed but little, the explanation being that the heat generated in the combustion chamber was rapidly transported to all points of the stroke by the piston. Most interesting and instructive were the indicator diagrams of the engine, taken by an indicator of the Hospitalier-Carpentier type. In this indicator the pressure is measured by a flexible diaphragm, which is coupled to a small mirror, which is deflected about a horizontal axis as the flexible diaphragm moves in and out under the variation of pressure in the cylinder. The same mirror is also caused to vibrate about a vertical axis, by being coupled to a small crank driven by suitable connections from the main shaft of the engine. The actual diagram is traced by a ray of light thrown by the moving mirror onto a screen and this diagram can therefore be obtained of practically any size desired. Fig. 3 shows some of the diagrams for which we are indebted to London *Engineering;* the pressure scale, it is stated, is not one of even parts. Perhaps the most striking feature of the diagrams as a whole is the large amount of power absorbed in engine friction. The dots shown in the diagrams near the compression line show the time of the ignition spark. The engine was fitted with an adjustable spring on the automatic inlet valve. In Fig. 3 the diagrams marked *A* were taken with the engine running light at 1430 r.p.m., the suction being throttled and full spring pressure being on the inlet valve. The maximum compression was 39 pounds per square inch, the mean pressure 15 pounds, and the indicated horse-power 0.32. The spark was retarded behind the proper point, both in this and the next set of diagrams marked *B*. It will be seen that the pressure actually falls for some time after ignition, the maximum being near the end of the stroke. In *B* the inlet spring was very weak, and consequently there was occasionally a loss of compression. The engine was run unloaded at 1850 revolutions per minute. The compression varied between 59 pounds and 67 pounds per square inch, the mean pressure was 19 pounds and the indicated horse-power 0.53. In *C* the throttle was half open, and the inlet-valve spring was stiff. As before, there was no load, but the spark was advanced beyond its former position. The compression was 46 pounds, the mean effective pressure 19 pounds, the revolutions 2430, and the indicated horse-power 1.15. This set of diagrams shows a large suction loss, owing to a stiff spring and a slow ignition of the weak mixture at the high speeds. The exhaust line is nearly atmospheric. All these diagrams were taken with a 10-kilogram diaphragm, and the remaining two, *D* and *E,* with a 20-kilogram diaphragm. In taking the diagrams represented in *D* the throttle was fully open, and the inlet spring adjusted to its best tension and the spark advanced. The engine was running under its full load. The speed was 1750 revolutions per minute, the mean effective pressure 78.5 pounds, and the indicated horse-power 2.05. The cylinder was kept cool by a fan fixed on the crank shaft, and as a consequence the compression line was kept low. The temperature of the cylinder at the middle of its length was 120 deg. Cent., and that of the cylinder head 140 deg. on the exhaust side, which was exposed to the blast of the fan, and 230 deg. Cent. at the other side. The diagrams shown in *E* were taken under similar conditions to the foregoing, save that the main fan was shut off and the cylinder was overheated, the engine being on the point of stopping from this cause. The revolutions were 1790, the mean pressure 72.7 pounds, and the indicated horse-power 1.96. The compression line, owing to the hot cylinder, is higher than in the previous set. The temperature at the middle of the cylinder was 300 deg. Cent., and at the head 400 deg. Cent. A small fan was kept running on the exhaust side to keep the exhaust valve from burning. The temperatures noted were measured with thermocouples, as previously stated. The experiments are of very great interest, particularly in view of the enormous powers claimed for their engines by makers of motor-bicycles. Apparently, of the 2.05 horse-power indicated, about half a horse-power was absorbed in engine friction. Professor Callendar finds that the engine generally stops from inefficient lubrication when the temperature of the walls reaches 300 deg. Cent.

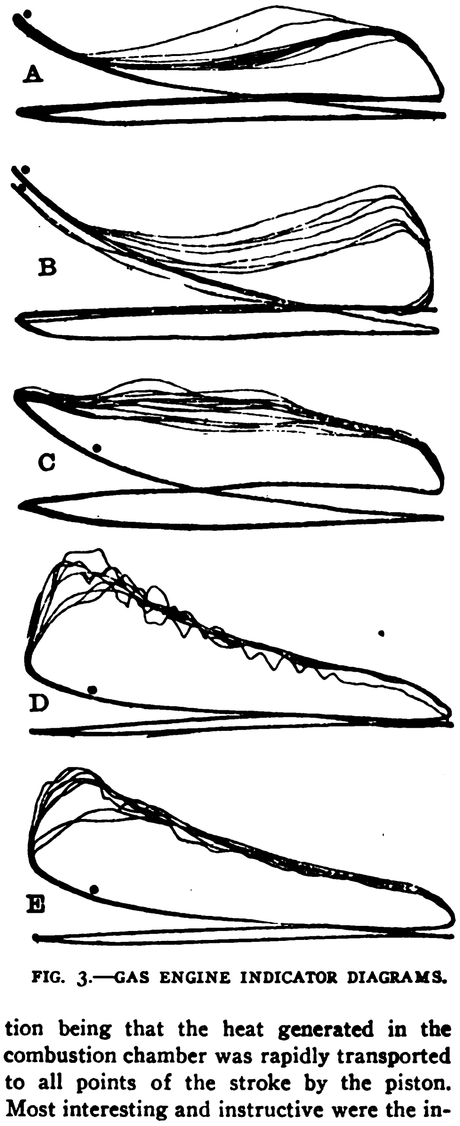

FIG. 3.—GAS ENGINE INDICATOR DIAGRAMS.

Electromagnetic Track Brake.—*The Electrician* of London gives the particulars of an electromagnetic brake for railways which the British Thomson-Houston Company is about to bring out. The general principles on which the brake is designed are clearly indicated in Fig. 4. It will be noticed that the brake proper is suspended from a stiff bracket, which is fastened to the side of the truck, by means of compression springs and wrought-iron eye-bolts. By using compression springs the advantage is secured that, even if a spring should break, the brake shoes are kept clear of the track. The brake shoe itself consists of a substantial steel casting with a cored recess, containing the magnetizing coil. This recess is closed at the top by a water-tight brass cap. A steel core extends through the coil, providing two magnetic circuits, each of which is completed by the action of rail immediately under the brake shoe. Wearing plates of cast steel are bolted to the underside of the shoes in such a manner that they can be renewed without removing the shoe from the truck. The magnetizing coil is supplied with current from the motors, when these are acting as generators, the current being led to the coil by means of flexible wires in duplicate, introduced through bushed holes into the recess of the cast steel frame of the shoe. It may be mentioned that the track brake is entirely independent of the ordinary hand brake. For single trucks two shoes are used, the coils of which are connected in parallel, and for bogie cars four track brakes are employed, two in series and two groups in parallel. The efficiency of the brake as an emergency and service brake has recently been demonstrated by a series of tests carried out under actual working conditions. A four-wheel double-deck car with two motors was used. The weight of the car was about 9 tons, and it carried five or six persons, engaged in the trials. When traveling at the rates of 25 and 14 miles an hour, the car was brought to a standstill in 4 and 1.6 seconds respectively, the stopping distance being 25 and 5.3 yards. In

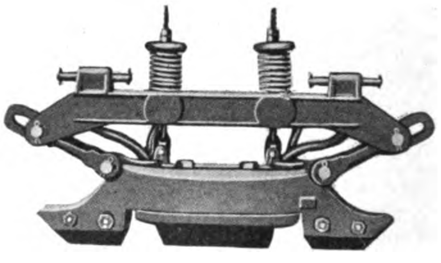

FIG. 4.—ELECTROMAGNETIC TRACK BRAKE.

the former case the car was on a down grade of 1 in 13, and in the latter case the car was running on a level grade. The first test represents extreme conditions; while the second test corresponds to the case of a car traveling at a moderate speed and obliged to pull up suddenly. A low and even speed can be maintained when the car is coasting down the steepest grades, and if necessary, the car can be stopped by further movement of the controller handle, and held at rest by the wheel brake.

The Inflammability of Twin Flexible Cord. —A joint contribution by J. Herzog and C. Feldman to the *Elektrotechnische Zeitschrift* gives the results of some experiments undertaken by the authors to determine the safety factor of twin flexible cord, such as is commonly used in connection with electric lighting installations. The tests were made with rubber-covered wire suitable for use in dry rooms, and designed for pressures up to 125 volts. Each conductor of the twin cord was composed of 24 copper strands 0.2mm. in diameter, the sectional area of the two conductors being, therefore, 2 × 0.75 square millimetres. The insulation consisted of a cotton covering, a thickness of Para rubber tape, and two braidings of cotton thread over all. In regard to insulation, the wire complied with the standards adopted by the Verband Deutscher Elektrotechniker. On the other hand, however, the composition of its conductors did not conform to these standards, which specify 0.75 square millimetres as the smallest permissible section, but fix 0.3mm as the minimum diameter for the copper strands. Referring to the accompanying diagram, curve *A* represents the temperature increase of the wire under a load of 20 amperes; four minutes after switching on the current the temperature was found to have risen by 70° C. Curve *B* was plotted from observations made with a load of 25 amperes; after four minutes the temperature rise had attained nearly double the previous value. With 30 amperes (curve *C*) an excess temperature of 150° C. was imparted in two minutes. Finally, as shown by curve *D*, the increase of temperature due to a current of 35 amperes amounted to 200° C. after 2 minutes 15 seconds duration. To prevent the ignition of the insulation before the completion of the observation, the current was reduced from 35 amperes to 32 amperes; the temperature increased within another minute to 240° C., and the wire began to glow. At this point the current was again increased to 35 amperes, and after the lapse of a further 30 seconds the insulation fired. The increase of temperature, it may be mentioned, was ascertained by measuring the resistance of the wire, assuming a constant temperature coefficient of 0.004. Now, the German safety rules allow a maximum continued load of four amperes for conductors of 0.75mm. cross-section, causing the temperature of the same to rise about 10° C. At the same time, the fuse must be designed to blow under the effect of double the maximum permissible current (in this case eight amperes) within the space of two minutes. But even four times this fusing current is insufficient to ignite the flexible cord within two minutes. The experiment also shows that the conductor is capable of carrying continuously a current of 20 amperes without its insulation being fired. Even supposing a 10-ampere or 16-ampere fuse were accidentally or purposely inserted instead of the 4-ampere one, these would be blown within two minutes by the passage of 20 amperes or 32 amperes respectively without ignition resulting. It is, consequently, wrong to suppose that the current due to a short-circuit between the conductors can fire the insulation of the wire over its whole length. But the case is different when one considers local inflammability. For instance, should broken strands of the core penetrate the insulation and cause the formation of an arc, to maintain which only a relatively small current is necessary, the phenomenon would involve a far greater element of danger. The small excess current might not suffice to blow the regulation fuse, while the insulation would be fired at the point of arcing. To avoid this danger, insistence on good material and workmanship is recommended. Further, it is pointed out that shop-window dressers should be warned against fastening flexible wire to draperies by means of pins, as also against the practice of knotting the flexible cord, etc.

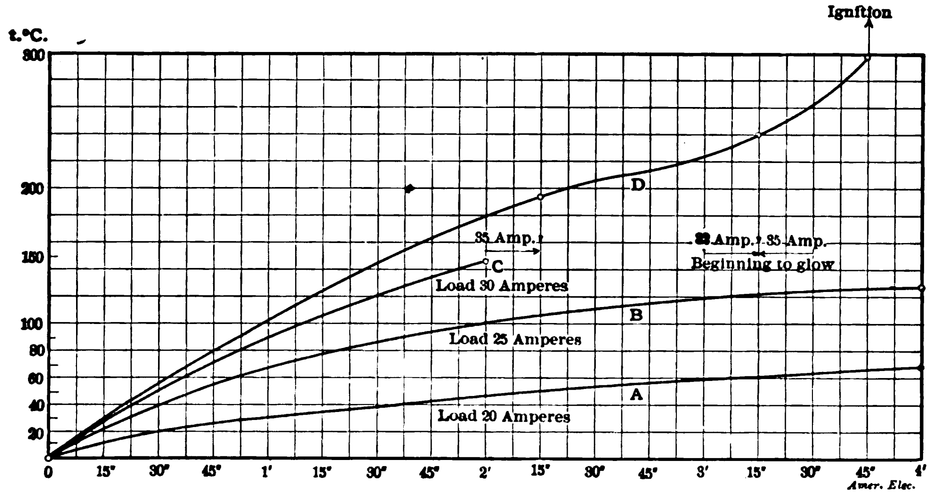

FIG. 5.—CURVES OF TEMPERATURE INCREASE IN TWIN FLEXIBLE CORD.

Three-Phase Electrolytic Rectifiers.—Emile Mors contributes to *L'Industrie Electrique* a description of an electrolytic device for the conversion of three-phase current into direct current. The apparatus involves the use of the electrolytic valve, and the connections used in this particular instance are shown by Fig. 6 herewith. Each of the wires of the three-phase system is connected to two electrolytic valves, in each of which there are two plates, one of aluminum and the other of some other material. As is well known such apparatus only allows current to pass in one direction. The two electrolytic valves on each wire are oppositely connected. It will be seen that the aluminum electrodes are connected to one of the wires through which the direct current is to flow, while the other is connected to the three plates of other material. With this arrangement the current in the rectified circuit is always in the same direction, and the curve of e.m.f. has undulations of exceedingly small amplitude. The author states that with a pure sine wave in the three-phase system the variation from the mean would be under 15 per cent. After trying this apparatus in its sub-stations at Clinchy and Courbevoie, the Société du Nord-Lumière has now decided to use them at these stations for converting three-phase current at 25 periods and 110 and 220 volts to direct current. In both cases the voltage obtained is considerably higher than the effective pressure of the currents applied, which the author states has not previously been the case in other attempts in the same direction, because the higher part of the curve of three-phase current has not been utilized. This increase in voltage in the case of three-phase current at 215 volts allowed of 230 volts being obtained on the direct-current side. This is used to supply six arc lamps in series. The efficiency as measured by two Aron meters has varied between 75 per cent and 78.5 per cent and the apparatus does not heat more than 20° C. over the surrounding air.

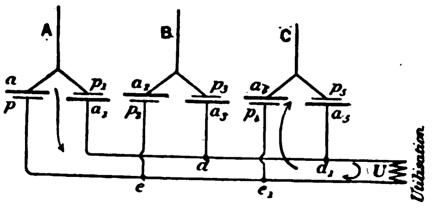

FIG. 6.—THREE-PHASE ELECTROLYTIC RECTIFIERS.

Oil Switches for High Tension Work.—The *Elektrotechnische Zeitschrift* publishes a report of an interesting paper read by Herr Volgelsang before the Elektrotechnische Gesellschaft zu Köln, in which the author deals with oil switches for high tensions. After reviewing the changes which have been made in the designs for high-tension generating plants since the first transmission scheme was carried out, the author goes on to say that modern practice has discovered two ways of constructing high-tension switches which can be relied upon to satisfy the more exacting requirements. One of these methods consists in the employment of the horn-break type of switch, while the other embodies the principle of interrupting the circuit under oil. Each has its advantages and disadvantages; the horn-break is only effective with heavy currents—the greater the current the more reliable is its action—a peculiarity which renders it especially adapted for use with fuses. On the other hand, the space which is required for its proper function is considerable. The author then discusses the oil switch—incidentally describing a type constructed by Voigt and Haeffner, Frankfort-on-Main, which is exceedingly simple. A three-pole switch is provided with six contact jaws, to engage with which there are three blades, so that each pole is interrupted at two points simultaneously. The oil is contained in a removable vessel of tin. The quiet action of this type is somewhat surprising, the interruption of the circuit being unaccompanied by noise. Experiments have shown that the formation of an arc under oil, just as in air, depends very largely upon the speed of the break. The author is of the opinion that the advantage of providing a large number of break points, especially in oil switches designed for very high tensions, will be more appreciated in the future, and thinks this principle better than that of employing extra long breaks under oil. He also points out that oil fuses are much less satisfactory in action than oil switches, because in their case one point of interruption only per pole can be provided. Moreover, at the moment of interruption the particles of melted metal along the path of the fuse assist the formation of an arc. For this reason oil fuses are used only for moderately high pressures, that is up to 3000 volts, and for relatively small currents. Within this limit oil fuses have proved thoroughly reliable. On the other hand, combination oil switches, in which the ordinary switch blades are replaced by fuses, have met with considerable success, especially in mines; but the practice of employing automatic cut-outs, instead of fuses, in conjunction with oil switches is quickly gaining favor, and it would almost seem that the use of oil switches with automatic releases in place of ordinary switches and special fuses has solved the difficulty hitherto connected with the breaking of high-tension circuits. The advantages of such an arrangement are obvious, especially in that the danger of fire which, in unfavorable circumstances, attends the blowing of tigh-tension fuses is avoided. In regard to oil switches with maximum current releases, the action is always indirect, being effected either by direct current through the medium of a relay or by alternating current through a rectifier. The latest phase in the development of this class of apparatus is the construction of automatic oil switches and cut-outs which can be operated from a distance. It is probable that this type of switch will find extensive employment for central-station work.

Measuring Alternating Current Potentials by the Aid of Condensers.—In a contribution to the *Elektrotechnische Zeitschrift,* Prof. W. Peukert deals with the use of condensers as an aid in the measurement of high potentials. He describes a modification of the principle whereby the range of a voltmeter may be increased by introducing a capacity into the circuit. Messrs. Siemens & Halske use a condenser for this purpose having a dielectric composed of porcelain plates; but the results, the author says, may be rendered independent of the periodicity by employing an air capacity. Since the voltmeter is also an air capacity, two similar condensers are in series the potential of the current being divided between them. Let a capacity C_1 (Fig. 8) be connected in series with an electrostatic voltmeter across an alternating current circuit having a potential E; also let the capacity of the voltmeter be C_2 and the potential at the two capacities be e_1 and e_2 respectively, then $e_1 \div e_2 = C_2 \div C_1$, or $(e_1 + e_2) \div e_2 = (C_1 + C_2) \div C_1$. But $e_1 + e_2 = E$ and $E \div e_2 = (C_1 + C_2) \div C_1$; hence $E = e_2\ (C_1 + C_2) \div C_1$. If now the capacity, C_2, of the voltmeter be known, one may vary the range of the instrument at will through the choice of C_1. For instance, if $C_1 = C_2$ then $E = 2\ e_2$, the range being doubled. It follows that the sensitiveness of the instrument may be varied within wide limits by means of this arrangement. Or, suppose one has an electrometer whose range is 200 volts and wishes to measure a pressure of 1500 volts, the capacity of the condenser required may be easily determined. Let the known capacity of the electrometer equal C, and that of the condenser to be discovered,, C_x, then $1500 = 200\ (C_x + C) \div C_x$; whence $C_x = 2C \div 13$. The air capacity employed consists of two metal plates, insulated from each other by glass stays, one of these plates being fixed while the other is adjustable by means of a screw motion. The capacity of such a condenser is, within certain limits, inversely proportional to the distance separating the plates, and one can, therefore, vary the capacity within these limits. In the above formula the capacity of the voltmeter is assumed to be constant, but this assumption would not hold in practice. On the contrary, one would have to find the relation between the capacity of the voltmeter and the potential at its terminals That is to say, one must determine its capacity for any potential. The measurement of what is, after all, the very small capacity of the voltmeter may be made by connecting it in circuit with a high non-conductive resistance (graphite resistance of several megohms) across a known potential. If E represent the latter and e_1 the potential indicated on the voltmeter, then the relation existing between these potentials and the potential, e_2, on the resistance is $E^2 = e_1^2 + e_2^2$, whence $e_2 = \sqrt{E^2 - e_1^2}$. Further, if R be the non-inductive resistance, then $e_2 \div R = i_0$, the charging current of the condenser, from which and the potential, e_1, the capacity may be calculated when the periodicity is known. By varying the resistance, R, the different deflections on the voltmeter are obtained and thus one is enabled to determine the capacity corresponding to any potential. In concluding, the author remarks that condensers have been successfully employed for the purpose described, both with electrometers and voltmeters, in the laboratory with which he is connected.

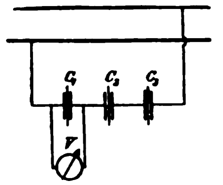

FIG. 7.

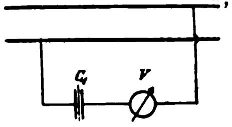

FIG. 8.

Phase Meter.—If an alternating current wattmeter be arranged so that for a varying load the current in the movable coil and the current in the fixed coil are constant, the instrument would be suitable, not for measuring the power, but for determining the power factor. For this purpose the arrangement shown by Fig. 9, taken from the *Elektrotechnische Zeitschrift,* is used. The fixed wattmeter coil is made of manganin so as to represent a distinct resistance, having a temperature coefficient practically equal to zero, and its terminals are connected to a voltmeter for control. Since the resistance of this wire is constant within wide limits, the voltmeter reading may be taken to determine the current in the fixed coil; if this reading is constant the current is also constant. In order to make the current constant and independent of the current in the consuming apparatus, a liquid resistance is connected in parallel with the fixed coil of the instrument. By manipulating the liquid resistance, the current J_1 in the fixed coil can be maintained constant while the current J changes. The current i in the movable coil is maintained constant by means of a rheostat W in series with it. Under these circumstances the reading of the wattmeter is directly proportionate to the power factor, so that the phase difference may be easily found.

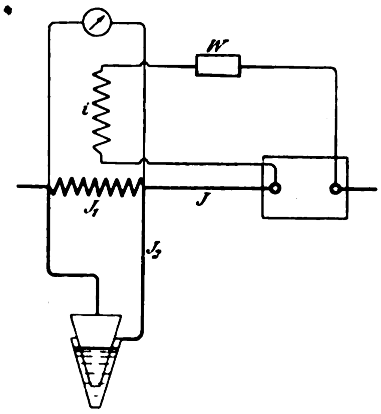

FIG. 9.—PHASE METER.

Frequency and Slip Meter.—*The Electrician* of London contains a note on a new device brought out by A. Bianchi, of Milan, for measuring the slip of induction motors. The whole apparatus is self-contained in a box of small size. A small electromagnet, with a polarized armature, is connected in shunt to the line through a contact-breaker. The latter consists of a disc of insulating material having (for a bipolar machine) one metal contact piece on its periphery, the disc being directly rotated by the rotor of the induction motor to be tested. Every time this contact piece passes beneath the brush, the shunt circuit referred to is closed and the electromagnet is energized. Since the frequency corresponding to the speed of the rotor is lower than the frequency of the line, it follows that contact is made each time at a different point of the primary wave. Each successive contact corresponds to a slightly advanced value of the line wave. The electromagnet is, therefore, energized by a current wave of the frequency v, equal to the difference of the frequency of the line and the frequency corresponding to the rotor speed. Since the armature of this electromagnet is polarized, it will be actuated in accordance with this wave of comparatively low frequency. The number, N, of the revolutions of the rotor is recorded by a speed counter and the frequency, v, is recorded by means of the electromagnet. The slip in per cent is calculated from the equation: $\text{Slip} = 100\, v \div v + (pN \div 60)$ and the impressed frequency is $v + (pN \div 60)$. In these equations $2p$ is the number of poles. If the induction motor has more than two poles, the rotating disc must have more than one contact; in fact, the number of contacts must be equal to the number of pole pairs. In Bianchi's apparatus, six different contact rings are provided, allowing motors with nearly every number of poles between 2 and 36 to be tested.

Direct-Current Voltage Transformer.—M. Aliamet describes in a recent number of *La Revue Électrique* the Lanhoffer system for varying the voltage of a direct-current generator. As is well known the voltage that can be obtained at the terminals of a direct-current generator cannot be varied within very wide limits, since the upper limit and the lower limit are very clearly defined. If the ratio of the highest and lowest voltage under which a dynamo can be operated successfully is called the coefficient of variation of the tension, this coefficient is generally below 1.5. The machine of Lanhoffer enables one to increase it over 5. It consists, as shown in Fig. 10, of two machines with independent stationary field systems while the two armature cores are mounted on the same axle. The armature winding passes over both cores. The excitation of the field N S is kept constant while the exciting current of the field V V' can be varied and reversed. For this reason a rheostat with a reversing switch is provided in the exciting circuit of V V'. The field N S may be excited either by a separate source of current or a method of self-excitation may be used; in the latter case the exciting current for N S is furnished from a special winding which is wound only around the core A_1 and not around A_2. If the e.m.f.'s induced in the common armature circuit by the field V V' are of the same sign as the e.m.f.'s induced by the field N S, the machine V A_2 V' acts as a booster; if the e.m.f's are of the opposite sign, this machine acts as a negative booster. The same arrangement may be used as a direct-current voltage transformer with the ratio of transformation being variable within rather wide limits. In this case, of course, a second commutator must be provided which is supplied from the external circuit at constant voltage. This commutator is connected to the armature winding of core A_1 alone. The transformed current is taken up from the brushes b b'.

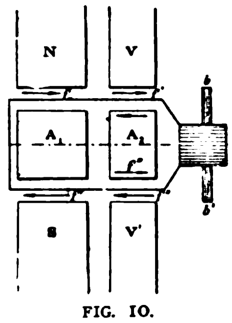

FIG. 10.

SOME RECENT ELECTRICAL PATENTS

Quick-Acting Magnet.—In order to decrease the time element of an electromagnet and make it respond and release promptly, Willis D. Gregory, of Pittsburg, Pa., has devised the type of construction illustrated by Figs. 1 and 2. In Fig. 1 the core of the magnet is cut nearly through at two points, 4, and in Fig. 2 it is shown cut entirely across. These constructions, of course, merely have the effect of dividing the magnet core into several very short lengths; it is well known that a relatively short core will change its magnetic condition more readily than a long one, and the inventor uses several short cores magnetically in series instead of one longer one. The avowed purpose for which this magnet is to be used is to operate the disc of a telephone receiver, but it is not apparent that the soft-iron cores of the ordinary receiver can be shortened enough to make any difference in their responsiveness. It would appear that laminating them, as a transformer core is laminated, would produce the desired improvement quite as well as, if not better than, the method proposed in the patent. Patent No. 753,879.

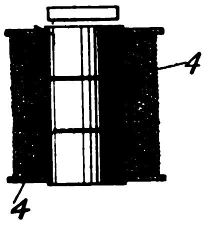

FIG. 1.

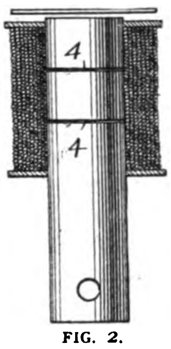

FIG. 2.

Anti-Sparking Dynamo Winding.—It is well known that the field distortion due to armature reaction in a direct-current dynamo or motor, and the sparking at the brushes which usually results if the brushes are not shifted as the load varies, may be corrected by providing a stationary winding so located with relation to the armature that its ampere-turns neutralize those of the armature winding. Such windings have been devised by Fischer-Hinnen, Thomson, Ryan and others, in different forms, but all of the same general character. The latest form of winding for the purpose mentioned is illustrated diagrammatically by Fig. 3, which is taken from a patent granted to Prof. Dugald C. Jackson, of Madison, Wis. It consists of a winding which is practically a counterpart of the armature winding and is located in slots cut axially across the pole-faces and non-magnetic bridges between adjacent poles. This winding is in series with the armature, so that the current in it varies exactly as the armature current and its ampere-turns are always equal to those of the armature. The current traverses the compensating winding in the opposite direction, of course, to that in which it traverses the armature winding, so that the reactive effect of the latter upon the field in the air-gap is neutralized. The arrangement has the obvious advantage that no special form of field magnet or main field winding is necessary; the pole-pieces and interpolar bridges are special, but these constitute a very small proportion of the total structure. It has the disadvantage that two complete armature windings are required, the compensating winding being substantially a duplicate of the armature winding. In view of the

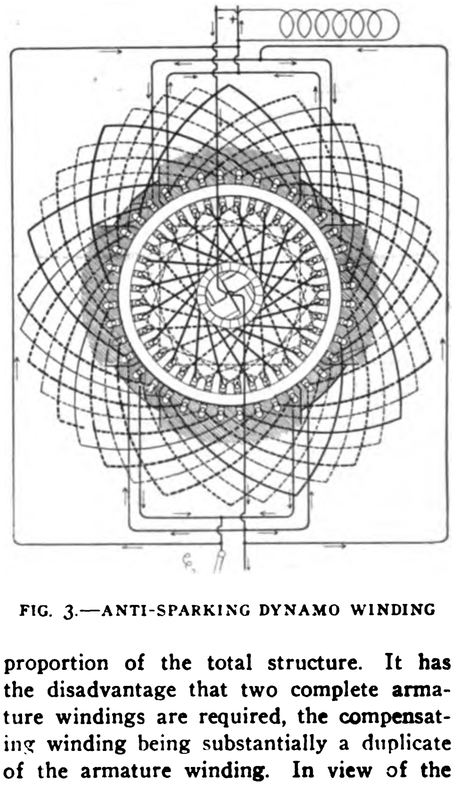

FIG. 3.—ANTI-SPARKING DYNAMO WINDING

well-known "state of the art" it is a mystery how Prof. Jackson succeeded in obtaining a patent for this winding; it is a perfectly obvious arrangement to anyone versed in the subject. Patent No. 743,082.

Three-Wire Balancer.—Motor balancers for preserving equality of potential on both sides of the neutral wire of a three-wire system are too familiar to require explanatory discussion. It is also a matter of common knowledge that the ordinary motor-balancer will not compensate for the increased drop in the "heavy" side of the system when it becomes unbalanced; so that considerable unbalancing of the load produces an objectionable degree of voltage unbalancing. This is also true of the now familiar balancing coil used with direct-current dynamos and of the transformer windings of a rotary converter outfit when the neutral wire of the direct-current distribution mains is connected to the transformer neutral. In order to obviate this disadvantage, Mr. Chas. P. Steinmetz proposes to use a series-wound booster inserted in the neutral wire of the direct-current system and driven by any suitable means, such as a constant speed motor. By properly connecting the field winding of the booster with relation to its armature, it is obvious that the machine can be adjusted to compensate automatically for variations of potential at the distribution center due to unbalancing of the load in either direction. Such an arrangement is shown diagrammatically in Fig. 4 in connection with a rotary converter system. The neutral wire, *s*, of the direct-current system is connected through the booster dynamo *E* to the neutral point of the transformer secondaries, which are connected up Y-fashion for that purpose. The detail at the right of the drawing shows an alternative arrangement of the booster, which is here connected with only its armature in series with the neutral tap and its field excited from the main wires of the direct-current system. The method involved is applicable to the so-called three-wire dynamo and compensating coil, as well as to a rotary converter system. Patent No. 745,460.

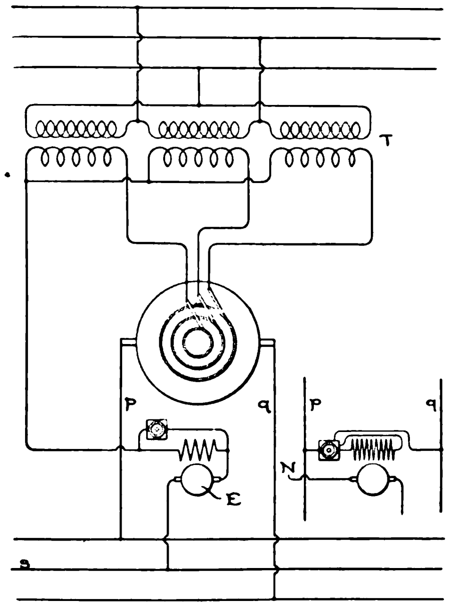

FIG. 4.—THREE-WIRE BALANCER.

NOTES.

The Ohio Electric Light Association will hold its next convention at Sandusky, August 16, 17 and 18, this year. Several papers of an unusually valuable character are promised.

Summer Schools for Artisans.—The third session of the excellent summer school for artisans, established by the University of Wisconsin, will open on June 27th this year. The school has proved of immense value to practical workers who cannot arrange for winter studies. Information may be obtained from F. E. Turneaure, Dean of the College of Engineering of the University.

A Warning.— The General Electric Company requests us to state that some one passing under the name of George E. McCants has been representing himself throughout Texas as the "chief electrician" or some other important official of that company, and that no such person is in the employ of the company. It is scarcely necessary to state that no one of the name mentioned was ever chief electrician of the General Electric Company.

More Factors in the Steam Turbine Field.—The Hooven-Owens-Rentschler Company, Hamilton, Ohio, has arranged to enter strongly into the steam turbine field. A 1500-kw. turbine has already been built and at last reports was about ready for test at the works; this will be exhibited at the St. Louis Exposition. It is also reported that the Warren Electric Manufacturing Company, Sandusky, Ohio, has perfected a line of steam turbines and is now entering orders for turbine-alternator units in outputs of 150 to 750 kilowatts.

The International Association of Municipal Electricians.—At a meeting of the executive committee of this association, held at Brooklyn, N. Y., April 2, the following papers were selected and assigned to be read at the ninth annual convention to be held at St. Louis, September 13 and 14, 1904: "Street Lighting; the Principles Involved and Systems Used," by A. S. Hatch, of Detroit, Mich.; "The Limitation of the Telephone for Fire Alarm Purposes," by Adam Bosch, of Newark, N. J.; "The Inspection of Theatres from an Electrical Standpoint," by William H. Thompson, of Richmond, Va., and "Methods of Testing," by Walter M. Petty, of Rutherford, N. J.

Electric Traction Tests on Swedish Railways.—Electric traction is to be tested on two experimental tracks each 8 km. in length, starting from Stockholm, it being contemplated in a near future to equip the whole of the Swedish state railways. Mr. Dahlander, acting as expert to the commission appointed for the purpose, advocates single-phase alternating current, which, apart from its well-known technical advantages, seems to be specially suitable in this case because of the great distances and relatively small traffic. The power is to be derived from the abundant stores of water power the country possesses, but for the experimental service now being installed, a provisional steam central station has been provided at Tomteboda.

Conventions at the Exposition.—The following societies have all promised to hold conventions at St. Louis during the International Electrical Congress week, and to hold conventions with one or more sections of the Congress: The American Institute of Electrical Engineers, The American Physical Society, The American Electro-Chemical Society, The American Electro-Therapeutic Association and The International Association of Municipal Electricians. The British Institution of Electrical Engineers has also arranged to cooperate under some plan, the details of which have not yet been determined. The Société Internationale des Électriciens, The National Electric Light Association and The Association of Edison Illuminating Companies have promised to cooperate by sending delegates.

To Regulate Electric Wiring.—A bill introduced into Congress some time ago for the regulation of electrical wiring in the District of Columbia, has passed the Senate and is now in the hands of the Committee of the District of Columbia on the House side. This bill makes it unlawful for any person to act as an electrical wiring contractor or to engage in electrical construction or installation, who has not been licensed or is not working under the supervision of some person so licensed. A further provision is to the effect that any person who shall knowingly employ an electrical contractor who has not been regularly licensed would be subject to punishment by a fine of not less than $5 nor more than $100, and in default of payment shall be confined in the workhouse for a period not exceeding six months. Any persons engaged in the business without a license shall be subject to a fine of not less than $5 for each and every offense, or by imprisonment not exceeding one month.

More Technical Light from the Daily Press.—A California newspaper enlightens a waiting world as follows:—

"In support of the statement that the solid globe and its atmosphere rotate in a direction opposite to that of the electric current I cite the case of an electric car. The dynamo in the new power house at Saratoga generates force, which is evidently derived from the inexhaustible reservoir stored in the earth and its air. From the dynamo the current passes eastward along the copper conductor and thence through the trolley to the car motor. When it reaches the bonded rails it at once changes its direction, the rails being in a negative condition. The iron is incapable of becoming permanently electric, as copper wires are when they are termed 'live wires,' but the copper bonds serve to establish a circuit, over which the current is attracted, after the car passes each of them, actually causing the car to move eastward while it passes westward. All the rails when thus united enable the negative tracks in front of the driving wheels to attract and pull the carriage in a direction opposite to the current's course."

A Novel Coherer.—Mr. C. Schniewindt, of Neuenrade, Germany, has devised a new wireless telegraph coherer which consists of a fine wire gauze made from a highly conductive metal, the wires of this tissue being cut through so that the wires, instead of running continuously from one end to the other, are cut into a number of short lengths. One type of apparatus includes a round piece of short wire gauze, separated by a spiral cut into a number of turns, the wires of which form by their terminals the edge of the windings. The spiral form, however, is by no means necessary, the cut being as well made in a serpentine or zig-zag line or even in a straight line, and the bands being connected alternately at one end or the other, as the cut does not run throughout the gauze. By dividing the wire lengths into various short sections, the resistance with respect to the electric current is made infinite. When the electric waves used in wireless telegraphy impinge on a piece of wire gauze thus prepared, the short wire pieces, being in contact with one another. cohere in a way similar to the metallic powder in the coherers so far used. By striking or jarring the coherer, the points of contact may be made to decohere.

Single-Phase Current for Standard Gauge Swiss Railways.—The use of single-phase current for standard gauge railways is being considered in Switzerland, where the Maschinenfabrik Oerlikon some time ago erected a standard-gauge experimental track 700 meters in length with a view to testing the practicability of their own traction system for electric railways, using high tension single-phase current in connection with a distinctive construction of the working wire as well as of the collectors. The collectors consist of bars having a convex curvature with respect to the trolley wire, and capable of rotating in bearings fixed to the car, only in a plane perpendicular to the direction of running, while being pressed against the trolley wire by some outside force. This arrangement allows of readily dealing with any ramification in the trolley wire and of giving the latter any possible position within the arcs of a circle drawn round the rotating point of the collector as centre, with a small and great radius corresponding to the straight lines connecting the centre to the lowest and farthest admissible contact points respectively of the collector and the wire. In order to improve the contact, the collector is developed to a surface. The experimental track is to be enlarged shortly.

The Use of Magnets in Connection with Cranes.—The danger arising from careless handling has been a material drawback to the adoption of magnetic hoisting devices. In the case of a magnet being used alone, there is the risk of the current being interrupted from some cause during the lifting and conveying of the material, and the men in charge of the crane being seriously endangered by the material falling. An ingenious device has recently been patented by the crane-building firm of Ludwig Stuckenholz, Wetter & Ruhr. Such magnets as are to be used, for instance, in transporting rails, tubes, etc., are combined with two pairs of grips or bows closing beneath the magnet. The working of the apparatus is as follows:

The magnets, being, as a rule, traversed by no current, are dropped on the objects to be transported and then excited by applying the current. Simultaneously with the lowering of the magnets the above mentioned tongs or grips will open automatically. After the magnet has lifted the material to be transported, the tongs close automatically, when the magnet may be switched off, leaving the tongs to transmit the lifted goods. This results, on one hand, in a saving of current, and on the other hand in enabling a transport to be made even above the heads of men working underneath without any danger to the men.

Producer Gas Plant Using Brown Coal Briquette Fuel.—An electricity works comprising a 100-horse-power producer gas plant and dynamo recently installed in Hoyerswerda, Germany, appears to be the first central station where the producer gas plant is operated with brown coal briquettes as fuel. The gas engine is identical with those used in connection with lighting and anthracite generator gas, and the producer plant is also quite similar to the usual arrangement, consisting of the generator proper, the dust collectors, the scrubber and the saw dust cleaner. Since the use of brown coal briquettes was adopted (in October last) it has been carried on continuously with most successful results and without any disturbances, the plant working about 14 hours daily; no reserve equipment has been provided until now. Another gas engine of the same output has been installed. Tests made sometime ago showed the cylinder to be free from impurities from tar or paraffine. The brown coal briquettes used were composed as follows:

Carbon	48.32	per cent
Hydrogen	3.35	"
Oxygen and nitrogen	26.54	"
Sulphur	1.09	"
Ashes	5.00	"
Moisture	15.70	"
Total	100.00	per cent

The calorific value is 4853 heat units [calories?] per kilogram (2.2 lbs.). A rough experiment intended for ascertaining the consumption of fuel was made for a period of 10 hours, the briquettes being unloaded from weighed buckets and the output being read on the ampere and voltmeter. This test showed a fuel consumption of 0.65 kilogram per horse-power-hour.

Operating gas generators with brown coal briquettes as fuel proves in many respects more convenient than using anthracite coal. The gas generator is never obstructed by slag, and after the normal intervals of idleness it may be started again without any blowing-in; the door leading to the ashpit may be opened during operation so as to clean the grate, which on account of the absence of any slag is relatively easy.

Incandescent Lamp Combination.—A series of meetings were held recently by the various incandescent lamp manufacturers of this country for the purpose of discussing prices, sales policies, the patent situation, etc. The last-named subject appears to have been the chief topic; the situation had begun to assume complex characteristics, but was cleared up by the licensing of most of the "independent" manufacturers by the General Electric Company and the old Edison Electric Light Company, owners of several important patents relating to manufacturing processes. The manufacturers who have been licensed are as follows: Downward Light Electric Company, New York; the Sterling Electrical Manufacturing Company, Warren, Ohio; the Brilliant Electric Company, Cleveland, Ohio; the Banner Electric Company, Warren, Ohio; the Franklin Electric Manufacturing Company, Hartford, Conn.; the United States Incandescent Lamp Company, St. Louis, Mo.; the Standard Electrical Manufacturing Company, Niles, Ohio; Capital Electric Company, Denver, Colo.; Gilmore Electric Company, Boston, Mass.; Liberty Electric Company, Pittsburg, Pa.; Warren Electric and Specialty Company, Warren, Ohio; the Colonial Electric Company, Ravenna, Ohio; Monarch Electric Manufacturing Company, Warren, Ohio; Shelby Electric Company, Shelby, Ohio; Bryan-Marsh Company, Marlboro, Mass.; the Buckeye Electric Company, Cleveland, Ohio; Munder Electric Company, Springfield, Mass.; Sunbeam Incandescent Lamp Company, Chicago, Ill.; Columbia Incandescent Lamp Company, St. Louis, Mo.; Independent Incandescent Lamp Company, Cleveland, Ohio; New York and Ohio Company, Warren, Ohio; Fostoria Incandescent Lamp Company, Fostoria, Ohio; General Incandescent Lamp Company, Cleveland, Ohio; National Electric Lamp Company, Cleveland, Ohio.

It will be noted that the Sawyer-Man Electric Company is not in the combination and that company has already issued a statement to the public to that effect. Four other concerns are not included, although it is intimated that some of them may still come in. It is claimed that over 99 per cent. of the lamp production of the country is represented by the capacity of the "pool" licensees. The present annual consumption of lamps is put at 45,000,000. The total productive capacity of the existing factories is placed at about 65,000,000.

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Central Station News.

In this issue we add a new department which we hope will meet with the appreciation of AMERICAN ELECTRICIAN readers. In this we shall endeavor to present all available information regarding current developments in both commercial and municipal central stations throughout the United States, Canada and Mexico, and our readers are cordially invited to contribute to the department any items of news relating to plants in their vicinity. So far as we know, no systematic effort has heretofore been made to record all of the many changes in plant equipment, policy and officials which occur from time to time, and it is the object of the new department to supply this important deficiency. Aside from its news function, this feature of the paper will, we believe, serve an excellent purpose in indicating the general trend of central station development.

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The Municipal Plant Question.

It has several times occurred that shortly after the publication, in this or some other journal, of a report showing favorable conditions in a municipal electric lighting plant we have received communications from readers in which the favorable report was quoted as a refutation of what our correspondents were pleased to call our "prejudiced utterances" against municipal ownership. We were unusually favored in this respect recently as a result of the commendatory remarks published in our Notes last month concerning the municipal plant at South Norwalk, Conn., and are thereby incited to state that we have no prejudices whatever on any subject; we have very clearly defined convictions on many subjects, and one of these is the municipal ownership of public utilities.

That a municipal electric light and power plant can be operated at the same cost as a commercial plant operated under identical conditions is a self-evident proposition, and one which we have never attempted to controvert. The whole question hinges on the practicability of establishing the same conditions for the operation of a municipal plant that characterize the operation of a privately owned plant. We have always maintained that *if* politics could be kept out of the control of the plant, a municipal plant could be operated just as any other one is, and with equally satisfactory results; the report of the South Norwalk plant merely vindicates this argument. The superintendent of that plant is allowed to operate it according to his notions of expediency and not according to the bidding of peanut politicians with massive axes to grind and knives up their sleeves already well-ground; consequently it is a success. This state of affairs, however, is about as common in municipal plants as Miss Helen Gould's brand of philanthropy is among millionaires.

Even when the conduct of a municipal plant is not affected by politics, there is a strong temptation for the active management of the establishment to "soldier," on the assumption that the question of profits is not nearly so important as in a commercial plant and that the city "can afford to pay for it" when the balance sheet does not show up as comfortably as it might. This attitude is quickly recognized by the subordinate employees, and the general tone of the work throughout the plant is lowered accordingly. This has been the case in several municipal plants we could mention, where political influences were not applied to the lighting department to an appreciable extent. Hence our contention that the successful operation of a municipal electric light station is, as a general rule, far less probable than that of a commercial plant in the same city. The municipal ownership of public utilities would not be detrimental in the slightest degree to the electrical industry if the plants were conducted on strictly business principles; only the capitalists would be affected, and there are numerous avenues of investment for them. As we have always remarked, however, the "if" is a huge one.

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Specialization.

It is generally recognized now that the fullest measure of success in any avenue of endeavor is to be obtained by specializing—making a thorough study of one class of work and pursuing that exclusively. It has been argued that the huge department stores and gigantic industrial establishments such as the General Electric and Westinghouse Companies are such colossal exceptions to the rule as to vitiate it entirely. The magnificent achievements of Helmholtz and Kelvin are also frequently cited as nullifying the rule. None of these examples, however, is in the least opposed to the maxim stated above. The department stores and industrial organizations are merely aggregations of specialists without whom (or others like them) the whole structure would be a dismal failure. The benefits of specialization are shared by those whose talent for organization enables them to make the best use of the efforts of those whom they aggregate; they themselves are specialists in this very direction. It requires no argument to show that the specialists grouped together in such organizations as those mentioned enjoy an immensely greater success than would be possible if they attempted general instead of special activity. Helmholtz, Kelvin and the few others of their standing are shining exceptions; if all of us had the mental equipment with which those men were blessed industries would suffer for the lack of "rank and file."

It should be remembered that specialization does not consist of knowing one thing perfectly and being an ignoramus on all other subjects. Broadness is as essential to the perfection of success as thoroughness in some one direction; but there is a wide difference between broadness of mental cultivation and a smattering of general knowledge which leads nowhere. The young man who determines to specialize should also determine to learn just as much about everything else besides his chosen occupation as time and opportunity will allow him to acquire; but he should avoid wasting time with the unimportant details of other lines of thought. The very best fireman (in a power plant) that we have ever seen had a fairly good grasp of social economy and a startling familiarity with Roman mythology. Of course, neither was in the least essential to a knowledge of fuel combustion and the evaporation of water in a boiler, but the man's mental development enabled him to consider his work far more intelligently than his fellows could, and to get correspondingly better results.

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Machine Tool Motors.

The application of individual electric motors to machine tools is a problem the solution of which usually upsets the preconceived ideas of the average machine-shop superintendent. The shop which he has operated successfully with a 25-h.p. motor driving all of the tools should not, in his estimation, require any more power for its operation when the tools are individually equipped; in fact, he naturally expects that less power will be required, because of the elimination of shafting and belting, and from these premises he is likely to make seriously erroneous deductions as to the sizes of the individual motors that are to be put in. Consequently, when he is assured by the consulting engineer or manufacturer to whom he has entrusted final responsibility that his motor equipment will aggregate three or four times the amount of horsepower that his old single motor developed, he is likely either to suspect that he is being "worked" or to insist that errors have been made in the calculations. A careful analysis of the matter will, of course, straighten out his misconceptions, if he has the intelligence of the usual shop superintendent.

The principal reason for the larger aggregate rating of the individual motor equipment as compared with a single motor is that each machine tool must be equipped with a motor capable of driving it at its maximum capacity, even though it may not be worked at that capacity more than once in a week; and when the tool is being worked at half its maximum ability, the motor operating at a slow speed may to some other machine, as is the case when several tools are group-driven by one motor. Moreover, under some conditions and with some systems of speed control, the motor can never be operated at its maximum ability. If the regulation is by means of voltage control, for example, a lathe motor operating at a slow speed may receive minimum voltage and maximum current; when at the highest speed, it will receive maximum voltage but the current will not be anywhere near the maximum, as a rule. Consequently, the machine never receives maximum e.m.f. and maximum current simultaneously, and is therefore never worked at its full capacity. With speed regulation by means of variable field excitation this particular disadvantage is, of course, not encountered. Everything considered, it is an extremely nice problem to determine the distribution of motors and the type of speed control best suited to machine-shop conditions. Each case must usually be treated as a special one.

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Our "How-to-Make" Articles.

Immediately following the editorial pages in every number of the AMERICAN ELECTRICIAN is published an article in which instructions are given in very full detail for the construction of some piece of electrical or mechanical apparatus; in this number, the subject is a three-phase synchronism indicator. Within a few days after each issue of the paper has been mailed we begin to receive requests for information as to how the apparatus described in the number just issued can be modified to fit some special conditions for which it was not designed. If it were at all practicable, we would be only too glad to grant all such requests, but we are compelled to refuse them either because the changes desired are absolutely impossible or because the apparatus was not designed in this office and we are therefore unfamiliar with the basis of its design and cannot afford the time necessary to "work backward" to it and obtain the necessary data for redesigning the apparatus, even if we could spare the time to re-design it for the new conditions.

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The Source of Current for Arc Lamp Circuits.

It is of considerable interest to note that notwithstanding the strong tide of enthusiasm which the many advantageous features of series alternating current arc lighting aroused when its practicability had been thoroughly demonstrated, the old direct-current system of series circuits supplied by constant-current dynamos continues to be manufactured and installed. Open arc lamps are not now used to anything like the same extent as before the advent of the enclosed arc, but the alternating-current system has by no means rendered the direct-current system obsolete. There are several facts and combinations of facts which very probably account for this. In the first place, the direct-current apparatus is simpler and more easily understood and maintained by those in charge of the smaller (and more numerous) central stations than the alternating-current apparatus. A constant-current Brush or Wood dynamo can be handled by anyone who has a little common sense and is at all familiar with electrical machinery, whereas most constant-current transformers and automatic reactance coils have more delicate organisms and, although perfectly simple in construction, are regarded by the uninitiated with some awe.

A more substantial argument in favor of direct-current arcs, however, is that for central stations of moderate size it is much safer to have the constant-potential and the arc-lighting circuits and supply sources distinct; a break-down of one system will then not affect the other. With the arc lighting circuits supplied through transformers or reactance coils from the same generator that supplies the constant-potential circuits, both branches of the service would, of course, be crippled by the failure of a machine, and unless the plant were of sufficient size to justify a reserve unit equal in output capacity to any of the active units, such a breakdown would be most serious. In stations of considerable size, the advantages accruing from the supply of all circuits from a common type of generator, if not from a single primary set of bus-bars, are so plainly obvious as to require no discussion and so great as to subordinate all such questions as circuit power factor, inductive drop and the like. There is the chief field for alternating-current arcs.

CONSTRUCTION OF A THREE-PHASE SYNCHRONIZER.

BY PAUL C. PERCY.

A most useful synchronism indicator may be produced by properly combining two small transformers, three incandescent lamps and a set of connecting plugs and sockets of the type commonly used for connecting up synchronizing lamps. One of the transformers must be three-phase (if the system is three-phase) and the other single-phase. Such an outfit is described in detail herein, and may be constructed with extremely limited facilities in the way of machinery and tools; the greatest care must be exercised, however, in applying and maintaining the insulation of the transformers.

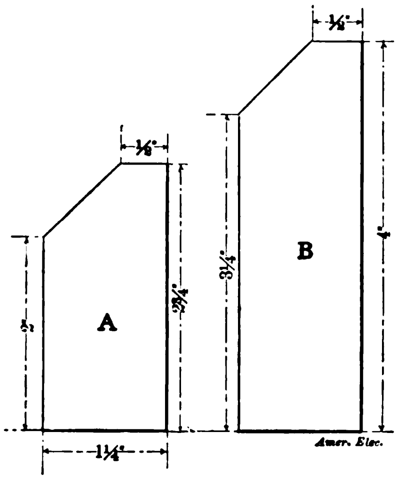


FIG. I.

The single-phase transformer is built up of rectangular strips of sheet steel each having one corner cut off, as indicated in Fig. 1; there must be two sizes of these strips, as the engraving shows, and of the dimensions specified in the sketch. The thickness of the sheet steel may be 25 mils; this would be too thick for ordinary transformer work, but as these transformers are in circuit only a very short time the increased core loss due to the thick sheets is of no importance. There will be required 80 strips of each size shown by Fig. 1, and these are to be built up to form a core of the shape and dimensions shown in Fig. 2. The core is 40 sheets thick and these 40 sheets should compress to about 1 3-16 inches, as indicated by the dimension stated on the edge view of the core.

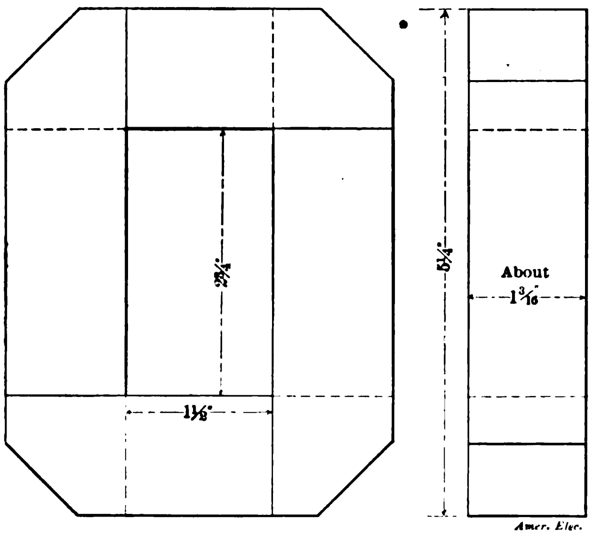


FIG. 2.—COMPLETE CORE OF SINGLE-PHASE TRANSFORMER.

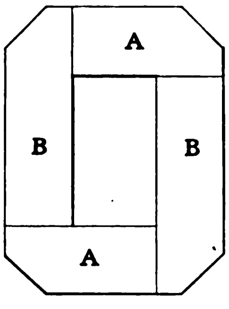


FIG. 3.

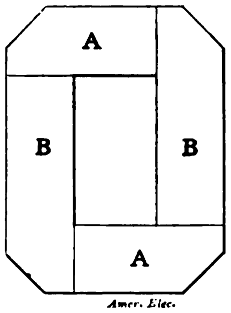


FIG. 4.

The strips must be staggered, so as to break joints, the first layer being put down as shown by Fig. 3, the second layer as shown by Fig. 4, the third layer like the first, and so on.

Before the core can be built up, the coils must be wound, taped and baked. The coils are wound in fibre bobbins, the heads of which are made of 1/8-inch hard fibre of the shape and size shown by Fig. 5. Two of these heads are fastened to the tube of the bobbin, one at each end, by means of thick shellac varnish. The tube consists of a sheet of 1/16-inch fibre 2 3/4 inches wide and 5 1/4 inches long, bent into tubular form so as to fit in the square openings in the heads. The bobbin must be mounted on a square wooden mandrel and the heads backed up by blocks tacked on the sides of the mandrel, so that the wire will not press the heads off the ends of the tube.

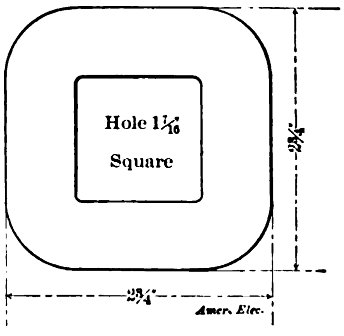


FIG. 5.

The secondary coil is wound on the bobbin first. It consists of 3 layers of No. 20 double-cotton-covered magnet wire in each bobbin (there are two, one on each leg of the core) with 60 turns in each layer: 180 turns in each coil. After winding this coil, it must be covered with six layers of oiled linen 0.01 inch thick, wrapped in one continuous strip the full width of the bobbin between heads (2 1/2 inches). Then four pieces of hard fibre 1-16 inch thick and of the shape and size shown by Fig. 6 must be glued to the inner face of each head so that when the primary wire is wound on top of the secondary the wires cannot pull down between the head and the edges of the oiled linen.

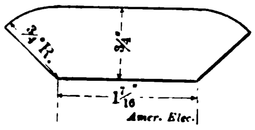


FIG. 6.

The primary winding in each bobbin consists of 8260 turns of No. 36 double-silk-covered wire, the silk covering being 2 mils thick; that is to say, the diameter of the wire measured over the insulation is 4 mils greater than the bare diameter. After winding on the first four layers of the primary, these should be covered with a thickness of the 0.01-in. oiled linen; a layer of this should be put in on top of each four layers of wire throughout the winding; six strips will therefore be required for this purpose. The outside of the complete coil should be covered with six layers of oiled linen and a protecting layer or two of heavy duck, the outer layer of this being heavily varnished. The two primary coils are to be connected in series so that if direct current were passed through them they would both magnetize the core in the same direction as to the complete magnetic circuit. The two secondary coils are also connected in series, and in agreement with each other.

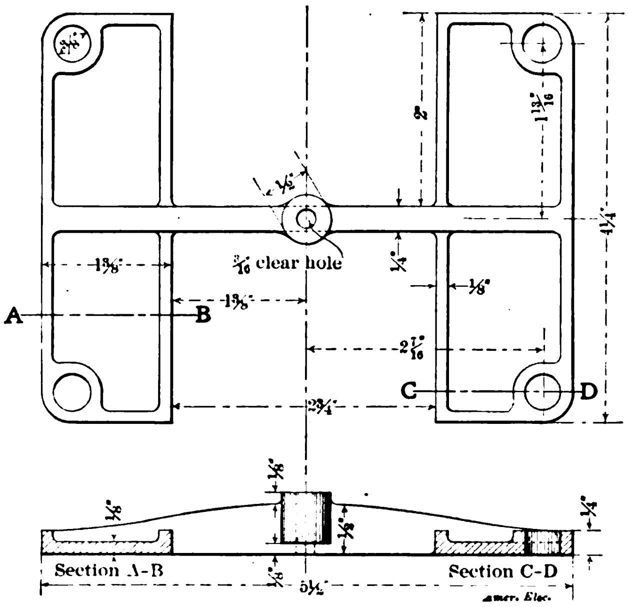
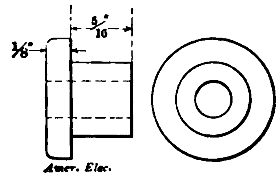


FIG. 7.—CLAMPING PLATE; SINGLE-PHASE TRANSFORMER.

After the core-plates are assembled, with the coils in place, of course, they are to be clamped tightly together by means of two brass plates of the shape and dimensions shown by Fig. 7, and five steel rods 3-16 inch in diameter, threaded at both ends; the clamping plates are to be drawn together by means of nuts on the ends of the rods. The plates must be insulated from the core by means of hard fibre facings 1-16 inch thick, the full size of the plate outlines. The rods in the four corner holes are insulated from the clamping plates by means of fibre bushings, one of which is shown in Fig. 8; the central bolt need not be insulated.

The three-phase transformer core is made up of sheet steel strips of four sizes; the shapes and dimensions of these are given in Fig. 9. The complete core, without the coils, is shown in Fig. 10; it is built up in somewhat the same manner as the core of the single-phase transformer. The first layer is put down as shown in Fig. 11, the second layer as in Fig. 12, the third layer like the first, and so on. The complete core must be 40 sheets thick.



Head ⅝" diam.
Sleeve ⅜" "
Hole 3/16" "

FIG. 8.—TIE-ROD INSULATOR.

This transformer has three sets of coils, and therefore three fibre bobbins. The bobbin heads are ⅛ inch thick, as in the previous case, but of the size indicated in Fig. 13. The bobbin tube is made and the bobbin mounted in the same way as previously described. The secondary coil on each leg consists of 360 turns of No. 20 double-cotton-covered wire, wound in three layers. This winding must be covered with six layers of 0.01-inch oiled linen, as before, and the four cheek pieces glued to the inner face of each bobbin. The primary winding comprises 11,790 turns of No. 34 double-silk-covered wire, with a layer of 0.01-inch oiled linen inserted after each *third* layer of wire, and the whole wrapped like the single-phase coil.

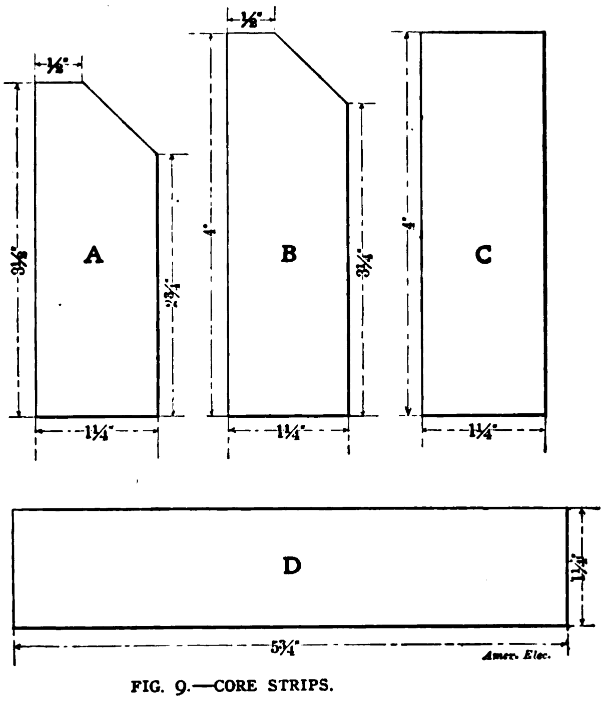


FIG. 9.—CORE STRIPS.

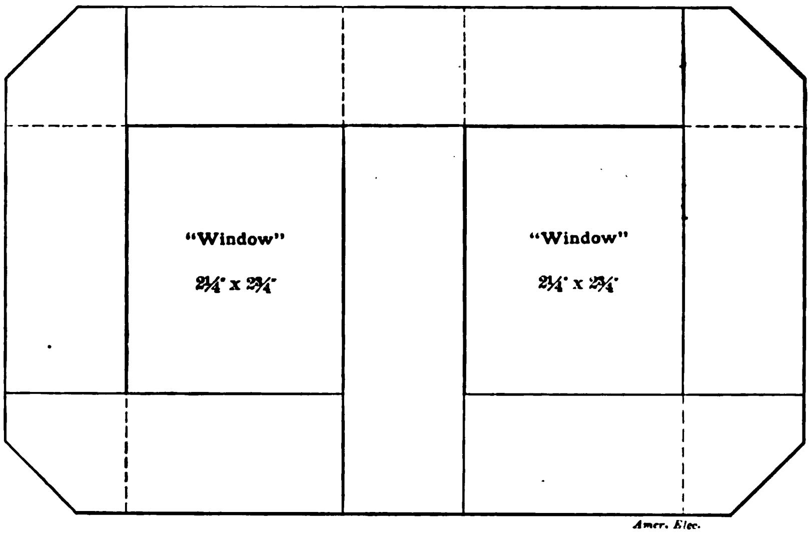


FIG. 10.—THREE-PHASE TRANSFORMER CORE.

The core sheets are pressed together by means of two brass clamping plates of the shape and dimensions shown by Fig. 14, six ¼-inch steel rods and two strips of ⅜-inch fibre carrying a metal strap at each end which is tapped to receive a 3-16 inch cap screw. Fig. 15 shows one of these strips; they go between adjacent coils, and the cap screws pass through the 3-16 inch holes in the clamping plates.

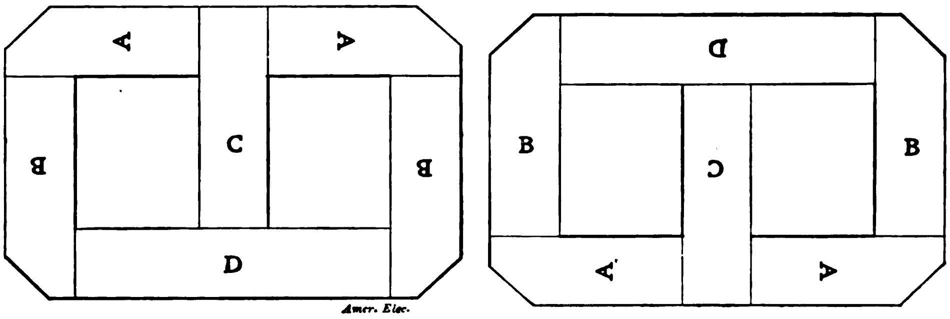


FIG. 11.—ASSEMBLY OF THREE-PHASE CORE STRIPS.—FIG. 12.

The connections of the outfit are shown by Fig. 17. The primary winding of the single-phase transformer is connected to "Phase A" of the bus-bar through a double-pole switch; one terminal of the secondary is connected to the neutral point of the lamp circuit, which is Y-connected, and the other terminal is connected to one terminal of all three of the secondary windings on the three-phase transformer, which are also Y-connected. The free terminals of the three-phase secondaries are connected to the free terminals of the three lamps.

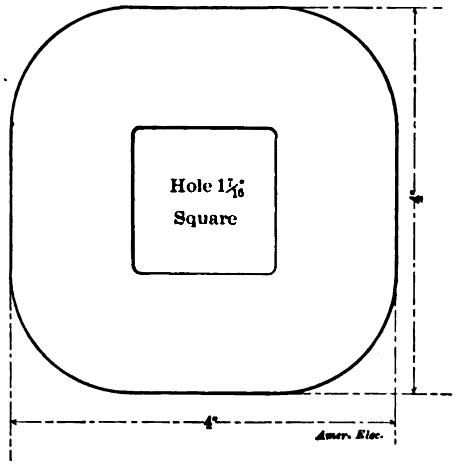


FIG. 13.

The primary windings are connected Y-fashioned, and the three terminals are plugged to the switch of the generator which is being thrown in.

If the connections are properly made with respect to the phase relations of the various coils, the lamps will glow in succession as the phases of the incoming generator agree successively with phase A of the system; this will give the effect of a revolving light, the speed of which will be proportional to the difference between the speed of the incoming generator and that of the machines already in circuit, and the direction clock-wise. As the incom-

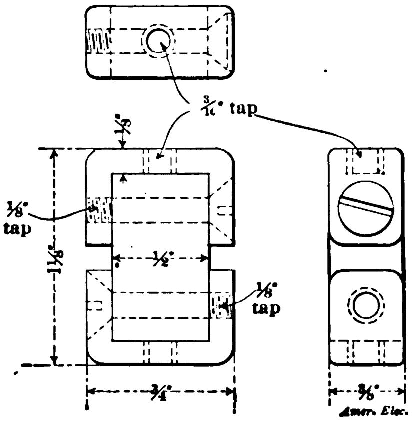


FIG. 15.

ing generator approaches synchronism, the speed of the "revolving light" will decrease, and when exact synchronism is attained, the top lamp (*a*) of the group will glow steadily and the others will remain dark.

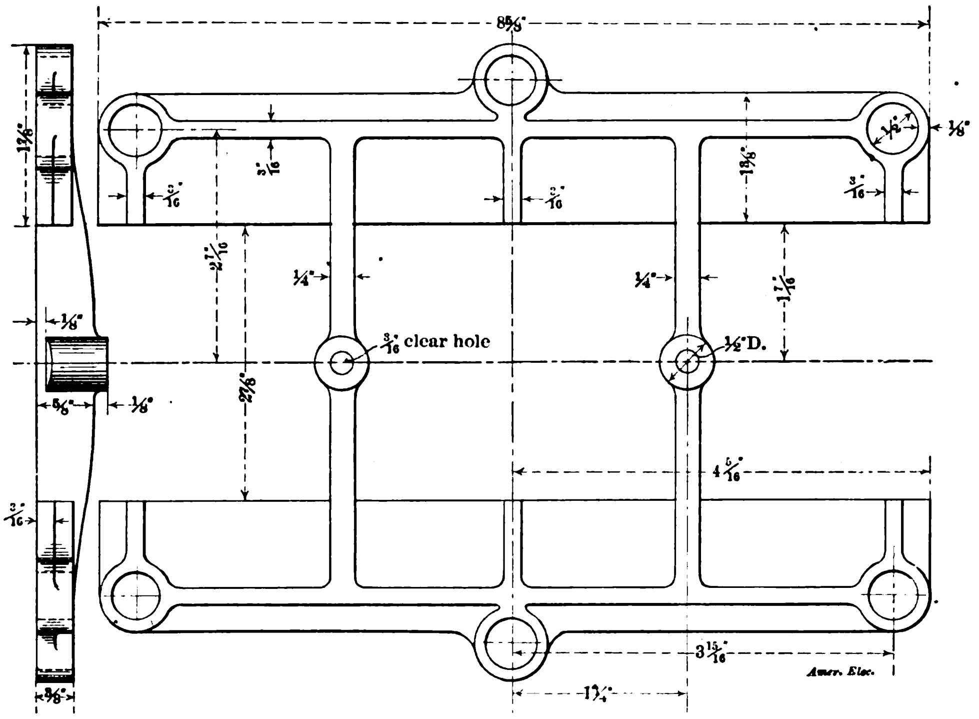


FIG. 14.—CLAMPING PLATE; THREE-PHASE TRANSFORMER.

It should be remembered that the steady glowing of either of the other lamps alone indicates identical speeds at the generators, but not coincidence of phases; if the lamp *b* glow steadily, it indicates that the generators are running at the same speed, but that phase B of the incoming machine is in step with phase A of the system, and the machine must, of course, not be thrown in.

The lamps should be rated at 100 volts and of low efficiency—say 64 watts consumption. The single-phase transformer is designed for a primary e.m.f. of 2300 volts and the three-phase transformer for 1626 volts per coil (2300 volts between free terminals); the secondaries should give 50 volts, but their voltage should be measured and lamps chosen which are of at least twice the voltage of each secondary, and preferably a volt or two higher. It is as well to repeat the warning given in the beginning of this article to the effect that the transformer windings must be most carefully handled and insulated in view of the high primary voltage. It is also essential that the rods which draw the clamping plates together be reliably insulated from the plates and from the core; it will be found a good plan to wrap them with a couple of layers of tape after the core is assembled.

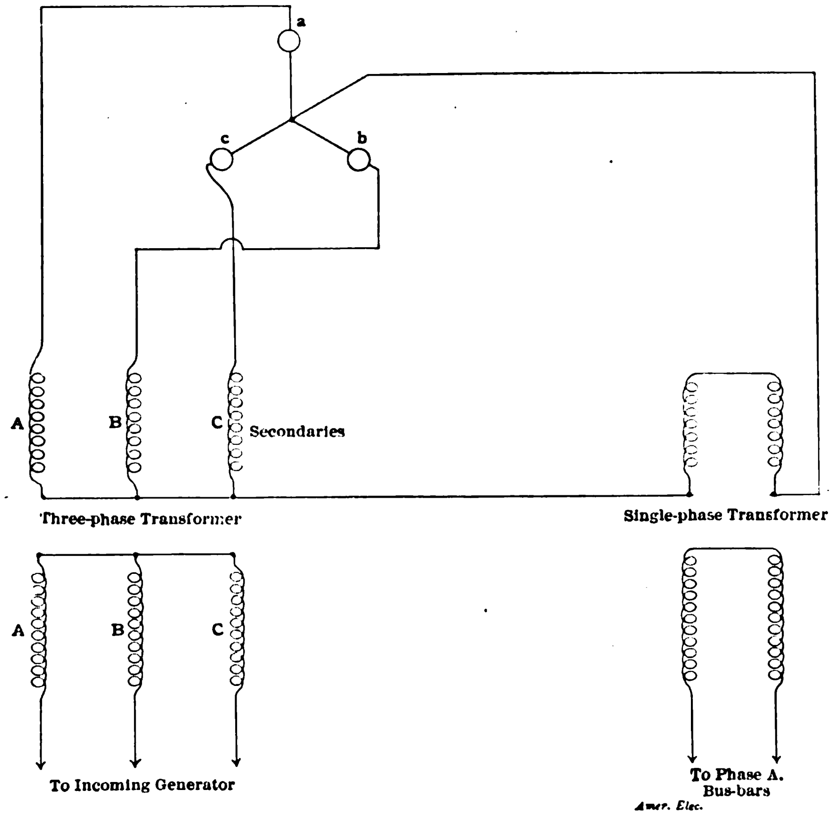


FIG. 17.—DIAGRAM OF CONNECTIONS.

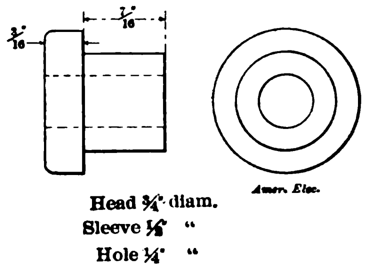


FIG. 16.—TIE-ROD INSULATOR.

PREPARATION FOR THE ERECTION OF AN ENGINE.

BY W. T. EDWARDS.

The principal and most important feature of the installation of a reciprocating engine is the foundation on which it will rest. The size of the foundation and the material of which it is constructed will depend upon varying conditions. The size, aside from the area required to accommodate the bed plate, will depend upon the bearing power of the soil; however, unless the soil is of an extremely low-bearing capacity, an increase over this area will hardly be necessary. In soft, marshy soil it is sometimes necessary to drive piles in order to get a satisfactory foundation, but when such conditions exist it would be wise to have an experienced engineer design and superintend the construction of the foundation.

Undoubtedly, hard pan or gravel is the very best base upon which to start the masonry foundation. Bed rock may be considered excellent, but there is a possibility of vibration being transmitted to the building, or adjoining buildings, which is objectionable, resulting in injury to walls, ceilings, etc., and this is likely to end in strained relations if not law suits between the proprietors of the affected buildings. Moreover, the excessive rigidity resulting from such a non-elastic combination is likely to cause the breakage of anchor bolts. To obviate this trouble, a layer of sand from 4 to 6 inches thick is used between the bed rock and the foundation. This has been very successful. Paper, felt and rubber have also been used for the same purpose with varying success.

The material used in a foundation should be of the best quality obtainable, and the workmanship should equal the material in quality. Concrete at the present time is in high favor for foundations; it is used for the engine foundations in the Manhattan, the Edison Waterside and the Interborough power houses. The ease of erection and the monolithic character it assumes when thoroughly set commends it for the purpose. In the erection of a foundation, concrete has the advantage over almost any other material in that after the forms are built little or no skilled labor is required to construct the foundation. That portion of a concrete foundation which lies below the surface of the ground may be built of rubble concrete; this is the same mixture that is used above the surface of the ground, but it has distributed through it what are called "one man stones," meaning stones that are as large as one man can conveniently carry. These are thoroughly wet before being imbedded and should not be placed nearer each other than 6 inches and not nearer than 4 inches to the surface of the work. The concrete may be made up of 1 part Portland cement, 2 parts clean, sharp sand and 5 parts broken stone or gravel. It is common practice to specify that no piece of stone shall be larger than 2 inches in its largest direction, and that the stones shall be screened, but it is now considered by very good authorities that the broken stone just as it comes from the crusher makes the best concrete, because there are fewer voids.

Using the proportions given, one barrel of cement will do for about two-thirds of a cubic yard of concrete. Concrete should be deposited in layers not more than 9 inches thick and should be thoroughly rammed until a film of water appears over the entire surface. If that portion of the foundation which is above the surface of the earth is to be exposed and it is desired to make it present a more pleasing appearance than it otherwise would, the corners may be neatly rounded by suitable fillets of tin in the angles of the wooden forms. These forms are made of dressed and matched lumber, and should be properly secured to prevent any bulging or twisting due to the pressure of the concrete. One way of securing a smooth finish is to deposit a layer of about 2 inches of cement mortar against the forms, this mortar being placed in position as the work progresses, not added as a plaster when the work is finished. While this material is being placed a workman inserts a tool resembling a spade with a long blade between the concrete and the form and manipulates it in such a fashion as to cause the cement mortar to assume a cream-like consistency against the form. This treatment is given to all surfaces that will eventually be exposed, and produces a surface that will equal some trowelled work. In case any portion of the foundation is light, due to recesses for exhaust or other pipes, corrugated or twisted steel rods may be used to reinforce; these are placed in their proper places while the foundation is being built and the concrete tamped thoroughly around them. There should be no portions detached from the main foundations, such as supports for bearings, as these will prove a source of trouble from unequal settling which will throw the shaft out of alignment. The foundation must be a single mass large enough to accommodate all the parts directly connected together.

In case it is convenient or desirable to have a brick foundation, the bricks should be of uniform texture, hard-burned, free from lime and other impurities; those bricks that are exposed should be of uniform size and have smooth surfaces, straight angles and be free from spalls or other defects. "Salmon" bricks, which are of a light color and soft, should not, under any circumstances, be allowed in any part of the foundation; they disintegrate very quickly. It is essential that the work be done by a skilled bricklayer and that the bricks be laid in a good quality of cement mortar, such as 1 part cement and 2 parts clean, sharp sand.

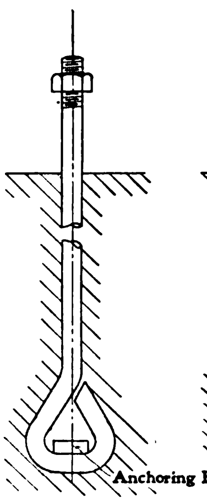


FIG. 1.

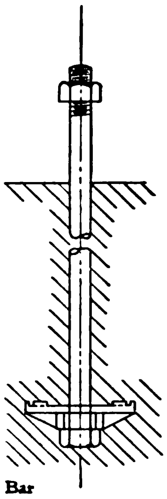


FIG. 2.

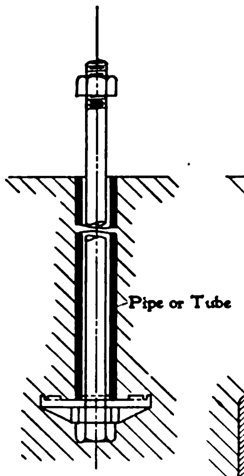


FIG. 3.

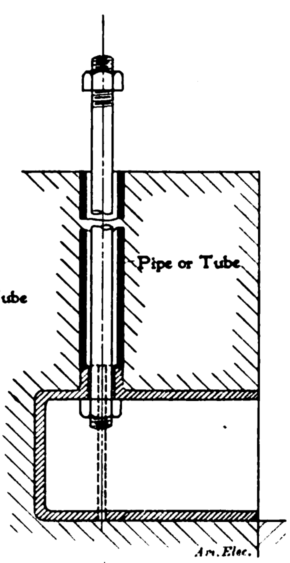


FIG. 4.

Too much care cannot be taken to have the anchor bolts exactly right, for after the foundation is once built it will be almost impossible to readjust the bolts to rectify a mistake. There is a difference of opinion about building the bolts in solidly or placing them in pipes or tubes, so that they may be free to move; however, the best guide is the practice followed on the most important work, and there pipes are used.

There are various ways of anchoring the bolts in position, several of which are shown by Figs. 1 to 4. Fig. 1 shows a stirrup turned on the bolt through which an anchoring bar or rod is passed, the whole being firmly built in the concrete or brickwork, as the case may be. Fig. 2 shows a bolt with a cast-iron washer built in solidly, as in Fig. 1; the bolt may be furnished with a head and nut, or with two nuts, one on each end, as may be more convenient. Fig. 3 shows the bolt passing freely through a pipe from the washer. An arrangement that is sometimes used, though it is a question if it is worth the expense, is shown in Fig. 4; this is a cast-iron box which takes the place of a washer or anchor plate and is made large enough for a man to turn up a nut by hand, reaching in from outside the foundation. In this case the bolts are generally placed in pipes, as such a box is usually put in only where there are likely to be broken bolts. The pipe is held in position on the box by a boss cast concentric with the hole through which the bolt passes. In brick foundations the equivalent of the cast-iron box is obtained by building in "anchor stones," which are about 10 inches thick, over pockets left in the brickwork; the bolts pass through holes drilled in the stones and are secured by means of ordinary nuts and washers.

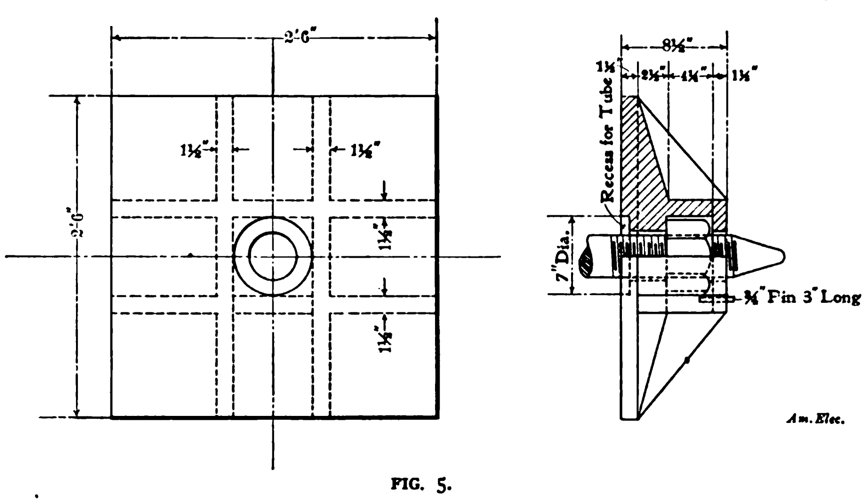


FIG. 5.

Where pipes are used with anchor plates, as in Fig. 3, the pipe is centered by a recess in the upper surface of the plate, concentric with the bolt hole; Fig. 5 shows this construction very clearly. This drawing is the detail of the washers used in the foundations for the engines of a power house in New York City. It will be observed that the nut is held on the under side of the washer in a box which forms part of the casting, and is prevented from falling out by a pin. The nut has a certain amount of freedom in the box, which permits it to adjust itself to the bolt in case there is any irregularity in setting the washers.

A template is indispensable to the correct location of the anchor bolts. It should be accurately laid out to match the bolt holes in the bed plate of the engine. These templates are sometimes furnished by the builders of the engines, but if they are not they should be made of lumber about 1 in. x 4 ins. in cross-section if the bolts are not larger than 1¾ inches in diameter; this will allow for a hole large enough for a 2-in. pipe to be bored in the 4-in. material. The template should be securely braced with diagonal braces to keep it in correct shape. If the engine is on the ground, measurements may be taken directly from the bed plate for making the template, but if not, the template will have to be made from drawings furnished by the builders. In order to avoid possibilities of mistakes, all bolts for any part of the engine should be laid out by one template; if some are at different levels, provision should be made by "stepping" the template to conform to the difference.

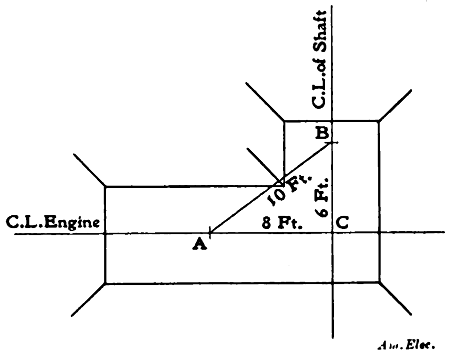


FIG. 6.

It is usually a problem to support the template at the proper height and rigidity, but if the foundation is to be of concrete this becomes quite simple, as it can be supported directly on the foundation forms. When the foundation is to be of brick or stone, scaffolding or horses are used. When the bolts are passed through the anchor plates, thence through the pipes, the top of the template should be placed at a height at which the tops of the bed plate bosses for the bolts will be when the engine is in its proper place. The bolts are given a good full nut and allowed to hang free from the template; sometimes the bolts are held in position at the lower ends, but not always. The pipes may be held concentric with the bolts by means of wedges. When the bolts are built in solid they are hung from the template, as described. If the bolts are not to be put in place until after the engine bed is set, the pipes are held by the template, the top ends of the pipes coming a little under the top of the foundation, and they are preferably plugged to keep foreign matter out. After the engine bed is set, a tap is put down through the pipe and into the nut contained in the anchor plate, so as to clean out the nut for the reception of the bolt.

Too much importance cannot be attached to having a center line from which to work. All work should be done from the center line of the engine and the center line of the shaft, as all the dimensions are laid out from these lines on the drawings. If one has the use of a transit and level and is able to lay out the work with these instruments, or can have the services of someone who can, all will be plain sailing, but if not, the lines may be laid off by means of the triangle method. Measure along the center line that is known to fix the location of the engine, a distance of 8 feet from the point of its intersection with the center line of the shaft; then lay off 6 feet along the line which will represent the center line of the shaft, and move it around until the diagonal from the 8-ft. mark to the 6-ft. mark measures exactly 10 feet; the lines are then perpendicular, to each other, or are 90 deg. apart. Fig. 6 explains it a little more clearly. The center line of the engine bed has been located definitely and it is desired to lay off the center line of the shaft square with, or perpendicular to, this line; lay off from *C*, the intersection of the two lines, 8 feet along the center line of the engine, or to *A*, and 6 feet on the center line of the shaft to the point *B*, and move this line about the center, *C*, until the distance *A—B* measures 10 feet; the lines will then be square with each other.

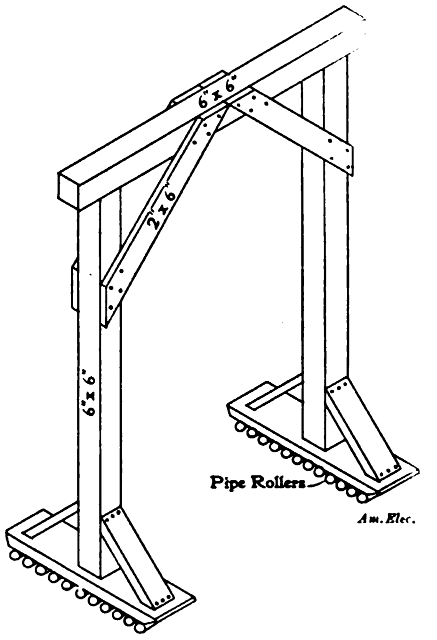


FIG. 7.

The foundation is never brought to the exact height required by the engine; a space varying from ¾ inch to 1½ inches is left for a "joint" either of sulphur, grout or "rust." This practice of having the foundation low gives a chance to level up by means of wedges or screws, or sometimes both. After the engine bed is leveled up, the space between it and the foundation is filled with one of the three named materials; if grout is used it is of neat cement, and as it is difficult to make perfect contact between the bed plate and the foundation in large work, holes are cored in the bottom of the bed plate called "grout holes," through which the grout is poured so that the grout is more completely and uniformly distributed over the surface. If a rust joint is desired, it is made of clean iron chips, which are thoroughly wet with sal amoniac and driven under the bed plate with tamping tools. Sulphur is used only for small work as a rule. When the bed plate is fixed, it is generally filled part full with concrete of the proportions 1 part cement, 2 of sand and 5 of stone; this will prevent the drum-like noise sometimes produced by the large hollow casting. Sand is used for the same purpose and is considered by some to be superior to concrete for the reason that some Portland cements expand on setting, thus exerting strains that have in some cases ruptured the bed plate. Whatever is used for a joint between the bed plate and the foundation, it should be protected from oil as the oil has a deteriorating effect on either concrete or iron joints. No opening should be allowed in the bed plate through which oil could get to the foundation. Sometimes shellac is used to cover the exposed parts of the joint, and this, to a certain extent, protects it from the oil.

It is well to have at least two hydraulic jacks (four are better) and not less than six wooden rollers about 5 inches in diameter; plenty of blocking which ought to vary from ½-in. stuff to 6-in. x 6-in. or 8-in. x 8-in. timbers; pulley blocks and rope of about 4½ inches girth, as well as chain hoists. Everything should be carefully prepared before beginning any work, as time will be saved thereby. A gallows frame may be made as shown by Fig. 7 and used with advantage for erecting the cylinders, shaft, etc. It should be made with a generous base to move on rollers of wrought-iron pipe. If the fly-wheel is solid and it is necessary to force it on the shaft, the clamps shown by Fig. 8 will be found cheap and convenient. The cross pieces may be of oak about 2 inches thick, or of flat iron about 1 inch thick, and if the engine is of the center-crank kind the cross pieces

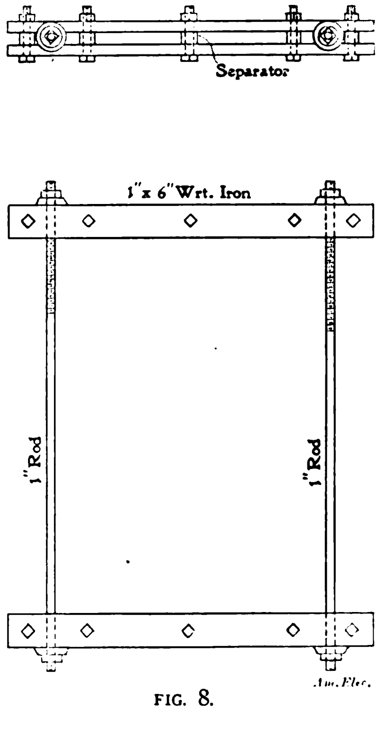


FIG. 8.

should be about 1 inch less in width than the space between the crank discs. The cross pieces should be bolted together in pairs, as shown, with about 1-in. bolts, using separators of pipe between. The rods should be not less than 1 inch in diameter, with two nuts, and each should have about 4 inches of thread on one end and about 15 inches on the other. These 1-in. rods will each have about 25,000 pounds ultimate or breaking strength.

The method of using this clamp is to block the fly-wheel up until it can be entered on the shaft, when it will usually go on a few inches quite freely, but will have to be forced the remaining distance to its bearing; one of the cross pieces is placed against the crank disc, provision being made to prevent the disc from being injured, and the other cross piece is placed outside of the wheel resting on two blocks of hard wood which bear against the face of the hub; the bolts are placed in position and the wheel pressed on by turning up on the nuts. The bolts should be spaced equal distances each side of the shaft and the nuts turned up equally; otherwise the wheel would be strained out of line and cramped or jammed on the shaft. Clamps are better for this work than a jack, as the strain is brought directly on the shaft and the whole is practically self-contained. Some engine builders tap a hole in the outboard end of the shaft to receive the end of a threaded rod about 3 inches in diameter, and about 2 feet 6 inches long; this rod takes the place of the clamp just described, being provided with a heavy nut and a yoke to engage against the hardwood block next to the wheel.

If the fly-wheel is in segments or in halves, the clamps will not be required, of course. If it is in two parts, one part can be lowered into the wheel pit before the shaft is in place and the other skidded over the shaft to its proper position and lowered on to the shaft and the bottom part lifted into place by long bolts passing through the hub. If the wheel is in segments, each part is fitted into the hub, the bolts driven into place and the links put in after the whole is in position. Sometimes the hub only is split, and a wedge driven into the split will open it enough to allow it to be slipped freely on to the shaft.

TABLE I.—SOME RATES OF INCOME FROM TELEPHONE SERVICE.

	Business.			Residence.		
	1-party.	2-party. *	4-party. *	1-party.	2-party. *	4-party. *
Baltimore Independent .	$48	$84	$128	$36	$60	$96
Louisville Bell	96	156	192	60	96	120
St. Paul "	84	144	216	60	96	144
Pittsburg "	125	200	320	100	160	240
Omaha "	——	——	——	66	96	144
Milwaukee "	96	144	240	60	96	144
Kansas City "	97	150	204	72	120	168

*Total income per line per annum.

In handling the bed plate, it will be found convenient to have it on rollers, as it can be moved directly over the anchor bolts and lowered onto the wedges ready for leveling.

The shaft may be placed in position by means of the gallows frame, Fig. 7, or it may be jacked up and blocked until it can be rolled over the bearings and lowered into place. The cradle for the shaft may be made of two 6-in. x 6-in. timbers and the shaft held in position by chocks. It is very important to follow any heavy work that is being jacked up by a good crib of blocking; this has been the means of preventing some very serious accidents. It is also important to be sure that everything is secure and safe before a block is cast off or a jack released; a little extra caution on these points may be the means of avoiding inconvenient, if not costly, accidents.

The cylinders can be very easily placed in position by means of the gallows frame, or may be blocked up to the proper height for entering the bolts connecting the cylinder to the frame and the whole moved forward by sliding the timbers supporting the cylinder on the blocking. Among the tools necessary is a good level; one that is moderately quick acting is to be preferred, and if it is one with an iron body, so much the better. It should be tested for truth. This may be done by placing the level on some approximately level surface and noting the position of the bubble, then reversing the level "end for end," being careful to have it in exactly the same place it was at first, and again noting the position of the bubble; if the bubble shows the same relation to the center line of the glass that it did at first the level is true; if not, it should be adjusted for one-half the difference.

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THE LEICH FOUR-PARTY SELECTIVE RINGING SYSTEM.

BY A. DALLAM O'BRIEN.

The advantages that accrue to the operating telephone company and to the telephone subscriber from the use of party lines are numerous. From the company's standpoint, the investment in wire plant required per station, where more than one station is connected to a line, is considerably less than in the case of a direct line, and by judicious grouping of the stations the additional circuit material required may, and usually does, in cities at least, amount to only a short length of overhead wiring from the terminal pole to the sub-station. From the standpoint of the subscriber whose use of the telephone is not excessive, the party line offers the required service at a yearly cost considerably below that of an exclusive line, and where the system used is selective there are no attending disadvantages with this decrease in rental. There is, of course, some additional equipment required both at the central office and at the sub-station for the operation of a selective party line system, but the annual charges on this investment represent but a small fraction of the profit due to the increased ratio of stations to lines.

Table I gives some figures showing the yearly charges for direct and party lines, in both the business and residence sections in a number of large cities, the figures given showing the total income derived from the line, from which the cost per station to the subscriber may be obtained by dividing the figures in the table by the number of stations connected to the line. The data contained in Table II was compiled by Mr. L. W. Stanton in connection with a paper read before the National Convention of Independent Telephone Companies, held in Philadelphia in 1902. This table shows the average cost per line for various numbers of stations, the income for the various classes, cost of operation, the interest and depreciation charges, and the net and percentage earnings per line for the different numbers of stations considered.

While the figures in this table may not apply in a great number of cases, their relative values may be taken as being fairly representative of party line practice. In order that party line systems may be made to appeal to the subscriber, they must of necessity be made selective, as signal ringing is very apt to lead to mistakes on the part of the operator and considerable annoyance to the subscriber. Where two stations are connected to a line, it is a very simple matter to render the signaling selective, as one station can have its bell connected from one side of the line to ground while the bell at the other station is connected from the other side of the line to ground and the apparatus at the central office adapted to send the ringing current over either side of the line. With a four-party system, it is obviously impossible to use the same simple means of connecting the stations.

TABLE II.

Number of stations per line.	Average cost per line.	Rental per line per year.	Cost to operate per line.	Interest on investment per line.	Depreciation 10% per line.	Total cost to operate. Interest and depreciation per line.	Net earnings per line.	Net earnings per station.	Net per cent. earned on investment per line.	Net % earned on investment per line, taking $36 as the rate for individual lines.	Net % earned on investment per line, taking $80 as the rate for individual lines.
1	$100.00	$48.00	$15.00	$5.00	$10.00	$30.00	$18.00	$18.00	18	6	50
2	125.00	72.00	22.50	6.25	12.50	41.25	30.75	15.37	24	9 2/7	63⅜
4	175.00	96.00	37.50	8.75	17.50	63.75	32.25	8.06	18	10 3/5	66 2/7
8	275.00	144.00	67.50	13.75	27.50	108.75	35.25	4.81	13	4	59 4/11

In the Leich system two instruments are connected to each side of the line and at the central office two generators are provided which furnish current at different frequencies. The arrangement of the circuit for a four-party line connected on this system is shown in Fig. 1, but before entering into a description of the arrangement and operation of the system it will be well to consider the principle upon which it operates. There are two types of instrument used with this system, the difference between them being entirely in the arrangement of the ringing circuit. Each type of instrument is equipped with a 1000-ohm ringer, a retardation coil and a condenser. The circuit arrangement of this apparatus, however, differs materially in the two cases. In operating this system there are two different sources of ringing current at the central office, one of which furnishes alternating current at 60 cycles per second and the other alternating current at 20 cycles per second. The division of the instruments into two types is due to the fact that one type is designed to respond to a ringing current of low frequency, while the other is intended for high-frequency current. In the low-frequency instrument, as shown in Fig. 1, a 2-microfarad condenser and a 2000-ohm retardation coil are connected in series with the 1000-ohm ringer, the free terminal of which is grounded. If Z represents the total opposition (impedance) that is offered to the flow of the alternating current, then by using the well-known expression

$$Z = \sqrt{R^2 + (2\pi)^2 f^2 L^2},$$

in which R is the resistance of the circuit to a direct current, f the frequency of the alternating current applied to the circuit, and L the co-efficient of self-induction of the circuit, it will be readily apparent that the impedance of the ringing circuit with the arrangement shown for the low-frequency instrument, will increase directly as the frequency of the ringing current increases, and that a point may be reached where the frequency of the ringing current has become so high and the impedance of the circuit so great that sufficient current cannot pass through the ringer to actuate it and cause an audible signal. With the high-frequency instrument, the arrangement of the ringing circuit consists in connecting a 0.3-microfarad condenser in series with the 1000-ohm ringer, the free terminal of which is grounded, and bridging the ringer with a 1000-ohm retardation coil. The action of a condenser in an alternating-current circuit is directly opposite to that of a retardation coil, the impedance offered to the flow of the alternating current by a condenser being represented by the formula

$$Z = \sqrt{R^2 + \frac{1}{(2\pi)^2 f^2 C^2}},$$

where C is the capacity of the circuit, the remaining symbols having the same significance as before. From this it is evident that the impedance offered to an alternating current by a condenser varies inversely with the frequency of the current, so that with the high-frequency instrument the impedance offered to the 60-cycle current is considerably less than that offered to the 20-cycle current.

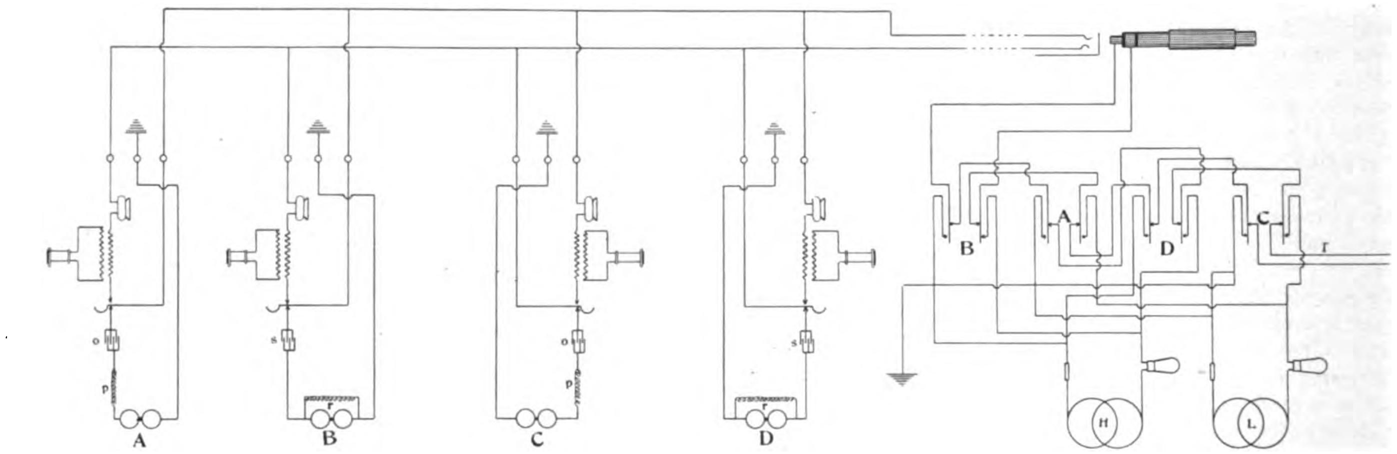

FIG. 1.—LEICH FOUR-PARTY SELECTIVE RINGING SYSTEM.

An inspection of Fig. 1 will show that to each side of the line are connected two instruments—a high-frequency and a low-frequency station from the central office, low-frequency current is sent out over the line and passes through the condenser, bell and retardation coil of the low-frequency instrument, and causes an audible signal. This current is prevented from affecting the high-frequency bell by the condenser which is in series with it and which offers a high impedance to the low-frequency current. The current that does pass through the condenser is diverted to ground through the 1000-ohm retardation coil which offers much less opposition to its flow than does the bell. If it were not for the fact that the actions of a condenser and a retardation coil in an alternating-current circuit are precisely opposite in their effects and that by a proper combination of the two the circuit may be made to act as though neither were present, the 2-microfarad condenser which is in series with the retardation coil of the low-frequency instrument would serve as a bar to the low-frequency current. As it is, however, the only effect of this condenser, so far as signaling is concerned, is to reduce somewhat the impedance offered by the retardation coil.

When a high-frequency current is sent out over the line it readily passes through the condenser and bell of the high-frequency instrument, the impedance of the bridged retardation coil being considerably more to the high-frequency current than that offered by the ringer coils. The low-frequency instrument is not affected by this current, as its ringing circuit offers too much opposition to the high-frequency current to allow a sufficient amount to pass through the bell coil and operate it. It will probably be well to explain that the retardation coil used in connection with the high-frequency instrument varies its impedance to currents of different frequencies through a wider range than do the ringer coils, for the reason that the impedance coil is wound on a laminated iron core and has a completely closed magnetic circuit.

The central office equipment necessary with this type of selective ringing can be varied to suit different operating conditions. Since the ringing current, as previously stated, is of two frequencies, this necessitates the use of two machines. For furnishing the current at 20 cycles per second, the regular two-pole alternating-current machine making 1200 revolutions per minute is entirely satisfactory, or a low-frequency pole changer may be used, and even the hand magneto generator will give satisfactory results. The high-frequency current can be obtained either from a pole changer or a small alternator delivering current at 60 cycles per second; the voltage in any case, with either frequency, should not exceed 90 volts.

Where the volume of party line traffic does not constitute a considerable part of the business handled in an exchange, it is possible to equip each operator's position with a single master ringing key which will determine the kind of current supplied to the cords for signaling purposes. When a master key is used, it is necessary for the operator in signaling the subscriber to first move the master key to the position in which it should be in order that the proper kind of ringing current be furnished to the cords, and then to operate the ringing key on the cord which is being used for signaling. With this method it is necessary to perform two operations in order to signal a party line, and the liability to error on the operator's part is thereby increased; so that it is only in instances where a very small volume of party line traffic is handled that this method is a good one.

The usual practice in large central offices consists in equipping each cord circuit with five ringing keys, all contained in a single mounting but having separate governing push buttons. One key is connected to a source of current—usually the high-frequency generator—and is used for signaling direct lines where the bell at the subscriber's station is not grounded. Each of the remaining keys is adapted to ring a particular party. For instance, key A in Fig. 4 sends low-frequency ringing current out over the ring of the plug, over the line and through the bell at Station A to ground;

key *B* sends high-frequency current in a like manner through the bell at Station *B* to ground, and keys *C* and *D* send low and high-frequency current respectively out over the *tip* conductor of the plug to ground through the bells at Stations *C* and *D* respectively. Thus with this equipment but one operation is necessary at the central office, the liabilities of error are decreased and the number of calls which an operator can handle increased.

A point in connection with party lines, which should be very carefully considered, is the designation of the individual lines, and as the number of stations which are connected to a single line increases this matter becomes more and more important. While opinions differ as to just what letters in the alphabet are suitable for this purpose, yet all exchange managers agree that those letters which are least liable to be confused and mistaken one for the other are the ones that should be used.

It almost necessarily follows that the calling rate per station for a party line is very materially lower than that of a direct line, and thus the number of party lines that an operator can handle does not fall much below the figure for direct lines, and indeed it often happens that the party line equipment in jacks per position may be made greater than that of any other class of service.

The particular impedance coil which is used with this system is so designed that its impedance may be varied to suit unusual line or switchboard conditions. For this purpose the core of the coil is made up of a number of E-shaped annealed iron punchings which can be readily inserted or withdrawn and the impedance of the coil adjusted thereby.

When the instruments are installed for use there are a few precautions which must be observed. The gongs should be in such a position that the bell hammer does not touch either of them when it is in its normal position on either side. It is also necessary to see that the armature of the ringer is in contact with the pole pieces when in either normal position, and it is, of course, necessary that a good ground connection should be obtained.

Instruments equipped with this type of selective apparatus have been successfully operated over lines up to ten miles in length without any adjustment whatever. This system is manufactured and marketed by the American Electric Telephone Company, of Chicago.

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A WAY TO UTILIZE OLD DRY BATTERIES

BY GEO. T. HANCHETT.

There are many cases in testing where a small amount of current is wanted for a long period of time, and at a few volts pressure only. Where the circuit is not to be broken, the most satisfactory arrangement is to draw the current from some power circuit using a resistance in series. In cases where the circuit is to be interrupted rapidly, as in the case of an induction coil, or in driving a small shuttle-wound armature, or similar arrangement, the arc at the point of interruption is beyond control unless special means are resorted to. Moreover if any attempt is made to measure the energy in a circuit thus interrupted, the readings will be entirely erroneous, or perhaps it is better to say the readings will be misleading because the energy of arc at the point of interruption is added to the useful circuit energy, and this is by no means small. For instance, in testing a small shuttle-wound motor, an attempt was made to run the armature with lamps in series across a 110-volt main. The sparking at the commutator was very severe, the potential around the armature was 25 volts and the current .9 ampere: a total power cousumption of 22.5 watts. When the same motor was run on a circuit of 4½ volts, the speed was practically the same, the current was 1.72 amperes, and the power in the armature circuit was 7.74. It was easy to see that the extra watts in the first test were consumed in heating the commutator, which quickly became hot enough to melt the solder.

The common expedient to obtain low voltage when only a high-voltage power circuit is available which will be free from troublesome reactions, is to connect the circuit to be supplied in multiple with a suitable resistance which is connected in series with the line. This resistance is not always easy to obtain, it is usually large and inconvenient, it is a source of heat, and always requires more current from the line than is used in the derived circuit.

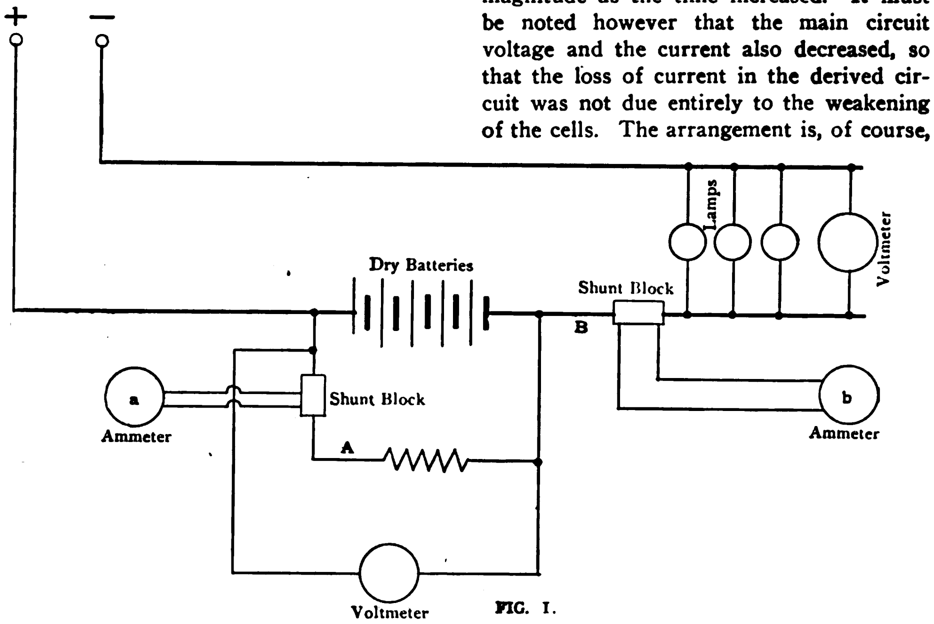

FIG. 1.

A very convenient means of eliminating this difficulty is to use a sufficient number of dry battery cells in place of the resistance, selecting such a number as will give an open-circuit voltage equal to the desired voltage at the work circuit. If the apparatus is so arranged there will be practically no current flowing through the dry cells when the work circuit is closed, so that they will not be a source of heat or trouble, they will form a very compact and convenient substitute for a resistance, having the additional advantage that they are usually easy to secure in comparison; moreover, their condition has very little to do with the result. They should of course be so connected as to oppose current flowing through them, and the reverse current which is sent through them when the work circuit is open tends to depolarize them in case they have been required for any reason to deliver any current to the circuit by virtue of their own voltage. The current in the work circuit may be either greater or less than the current taken from the line, according to the conditions.

In a test where a few volts was demanded, a number of dry cells arranged as shown in the accompanying diagram gave the following results:

Time.	Current in *A*.	Current in *B*.	Volts, V_1.	Volts, V_2.
3.40	2.98	1.9	2.68	114.2
3.45	2.8	1.9	2.53	114
3.50	2.71	1.9	2.48	114.5
3.55	2.65	1.89	2.46	114
4.00	2.62	1.89	2.45	114
4.05	2.59	1.89	2.44	113.5
4.10	2.54	1.88	2.41	113.5
4.15	2.53	1.87	2.4	113.5
4.20	2.52	1.87	2.4	113
4.25	2.5	1.89	2.4	113.7
4.30	2.49	1.9	2.39	113.4
4.35	2.48	1.9	2.38	114
4.40	2.47	1.9	2.37	113.8
4.45	2.46	1.89	2.36	113.4
4.50	2.45	1.87	2.34	113.2
4.55	2.44	1.88	2.34	113
5.00	2.42	1.87	2.33	112.8
5.05	2.4	1.86	2.3	112.2
5.10	2.39	1.86	2.29	111.9

In this case the current demanded in the work circuit was greater than the current taken from the main circuit, and fell off in magnitude as the time increased. It must be noted however that the main circuit voltage and the current also decreased, so that the loss of current in the derived circuit was not due entirely to the weakening of the cells. The arrangement is, of course, of experimental value only and simply consists of a convenient form of resistance which absorbs no energy.

In the case of a three-wire system where the neutral is grounded, a bell circuit might be supplied in shunt to a set of dry cells connected in series with a lamp circuit which was continuously alive, and on the side next to the neutral wire; if the current in this lamp circuit is kept down to a reasonable amount, say that for 1 or 2 lamps, it is probable that very little trouble would be experienced in the battery in a number of years, and the insulation of the electric lighting circuit would not be endangered by the addition of the bell circuit, as the latter would be practically at the same potential as the ground. The greatest value of the battery "resistance," however, is its convenience as a laboratory expedient

Lessons in Practical Electricity

COMBINED CAPACITY AND INDUCTANCE—POWER FACTOR.

As previously explained, any two parallel conductors constitute a condenser; as also explained, capacity, or condensance, produces effects which are opposite to those produced by inductance. Some classes of alternating-current apparatus affect the circuit to which they are connected exactly in the same manner as a condenser would; it is frequently the case, therefore, that an alternating-current circuit contains both condensance and inductance, and a consideration of the joint effect of these is of practical importance.

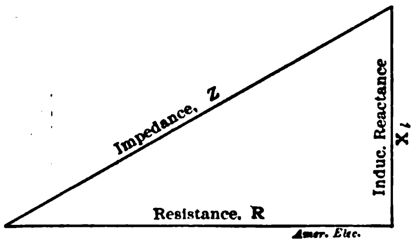

FIG. 1.

Condensance causes the current in an alternating-current circuit to rise and fall *ahead* of the e.m.f. of the circuit; under this condition the current is termed a "leading" current. Conversely, inductance causes the current to rise and fall after the e.m.f. of the circuit rises and falls, and such a current is termed "lagging." It is possible to combine capacity and inductance in a circuit so that their effects on the current phase neutralize each other and allow the current to rise and fall exactly in unison with the e.m.f. of the circuit. This result will be obtained when the inductive reactance and the condensive reactance are numerically equal and are also distributed alike in the circuit.

The inductive reactance, X_l is equal to $2 \pi f L$; the condensive or capacity reactance, X_c, is equal to $\frac{1}{2 \pi f C}$. In these equations f represents the frequency of the e.m.f. in cycles per second, L represents the inductance in parts of a henry,* and C is the capacity in parts of a farad.* The impedance of a circuit containing resistance and inductance is

$$Z = \sqrt{R^2 + X_l^2}$$

and the impedance of a circuit containing resistance and capacity is

$$Z = \sqrt{R^2 + X_c^2}.$$

When a circuit contains both inductance and capacity, the net reactance is equal to the arithmetical difference between the inductive reactance, Xl and the capacity reactance Xc. Therefore the impedance of a circuit containing resistance, inductance and capacity is either.

$$Z = \sqrt{R^2 + (X_l - X_c)^2}.$$

or

$$Z = \sqrt{R^2 + (X_c - X_l)^2}.$$

according to whether X_l is greater or smaller than Xc. It is obvious that when X_l and X are equal, the difference between them is zero, making the impedance, Z, equal to $\sqrt{R^2}$, which, of course, is R. When this is the case, the circuit operates as though there were neither inductance nor capacity present, and the current therefore rises and falls in unison with the e.m.f.

This may perhaps be made clearer by the use of the triangle diagram explained in the February Lesson and a similar diagram showing the relations of capacity reactance, resistance and impedance. Fig. 1 is the diagram showing the relations between resistance, inductive reactance and impedance and Fig. 2 is the corresponding diagram for resistance, capacity reactance and impedance. It will be observed that the line representing capacity reactance projects downward from the horizontal resistance line, while the inductive reactance line projects upward; this indicates the opposite character of the two properties, inductance and capacity, as regards their effect on the e.m.f. and current in the circuit. When a circuit contains both inductance and capacity, the *difference* between the lengths of the lines representing inductive and capacity reactances will represent the resultant or net reactance, X, of the circuit, as indicated in Fig. 3. Here, the capacity reactance, X_c, is one-third as great as the inductive reactance, X_l; the resultant or net reactance, therefore, is two-thirds as great as the inductive reactance, and the impedance line is drawn from the base line to a point two-thirds up the line representing inductive reactance. The dotted line *a* shows what the impedance would be if there were no capacity in the circuit, and the other dotted line *b* indicates what the impedance would be if the inductance were absent. It is obvious that if the line X_l and the line X_c were of equal length their difference would be zero, and the impedance line would be identical with the resistance line, indicating the equality between the resistance and impedance that the formula would indicate under the same conditions.

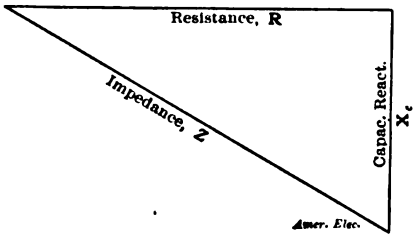

FIG. 2.

When either inductance or capacity alone is combined with resistance in an alternating-current circuit, the current either lags or leads the e.m.f., as already explained. The power developed by the combined current and e.m.f. is the product of the e.m.f. (mean effective value, of course) and the *instantaneous* value which the current has when the e.m.f. is at the point in its rising or falling which corresponds to its mean effective value. This product is always less than the product of mean effective e.m.f. and mean effective current, taken separately; multiplying the e.m.f.* by the current* gives the *apparent* power of the circuit, but the actual or true power is obtained by multiplying the apparent power by a number called the "power factor," which is always less than 1. The triangle diagram affords a most convenient means of considering these relations.

Referring to Fig. 1, if the two lines at right angles are plotted to scale so that their lengths are proportional to the resistance and inductive reactance of the circuit, the length of the diagonal line will necessarily be proportional to the impedance; dividing the length of the base line by the length of the diagonal line will then give the power factor of the circuit. This is also true of Fig. 2, the vertical line being plotted to represent the value of the condensive reactance, and of Fig. 3 where both inductive and condensive reactance are represented. From the foregoing, the following relations result:

$$\frac{\text{Resistance}}{\text{Impedance}} = \text{power factor.}$$

$$\frac{1}{\sqrt{1 + \frac{\text{Net reactance}^2}{\text{Resistance}^2}}} = \text{Power factor.}$$

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*In practice the inductance is never as much as a henry and the capacity never as great as one farad.

*The mean effective values are always meant unless some other value is specified.

Letters on Practical Subjects

A Belated Credit.

A correct reading of Mr. Ryder's meter was received from Mr. A. V. Youens, Wilkinsburg, Pa., on March 6th, but his name was unaccountably omitted from the list of correct readers published in the April number.—EDITOR.

Mr. Hartwell's Voltage Disturbance.

To the Editor, American Electrician:—

Referring to the voltage trouble mentioned by Mr. Ernest F. Hartwell in your April number, I would suggest that he use a Tirrell regulator connected to the center of distribution and controlling the field rheostat of the dynamo of a small motor-

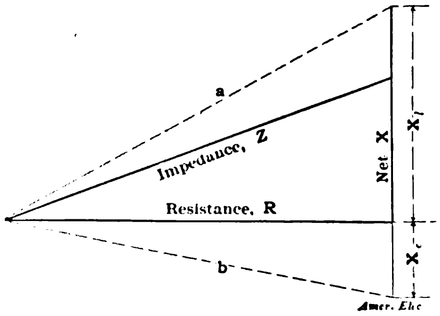


FIG. 3.

dynamo set. The armature of the dynamo end to be connected in series with the feeder and act as a booster, and the field of the dynamo and the entire motor of the set to be connected at the center of distribution. The motor-dynamo set, though small, would be somewhat expensive remedy; perhaps some other reader can suggest a cheaper method of correcting the trouble.

HENRY MULFORD.

Patchogue, L. I., N. Y.

Mr. Mahaffey's Bell Circuit.

To the Editor, American Electrician:—

I enclose herewith a diagram of bell connections (Fig. 1) which I believe to be a correct solution of Mr. Mahaffey's problem published in the last number of the AMERICAN ELECTRICIAN. The arrangement here shown requires about 460 feet of wire. As I understand the problem, the bell at Station A must not ring when either one of the push-buttons at that station is depressed to ring the distant, and the bell at B must not respond to the push-button there. I have therefore used three-point push-buttons or strap keys and a battery at each station. Depressing one of the buttons disconnects the line-wire *a* from the home bell and connects it to the positive terminal of the home battery, thereby ringing the distant bell only. It makes no difference, of course, whether the positive or the negative terminal of the battery is connected to the line-wire *a* when a button is depressed, but it should be the same terminal of each battery so that if the button at Station B and one of those at Station A were pushed simultaneously the two batteries would not be short-circuited on each other.

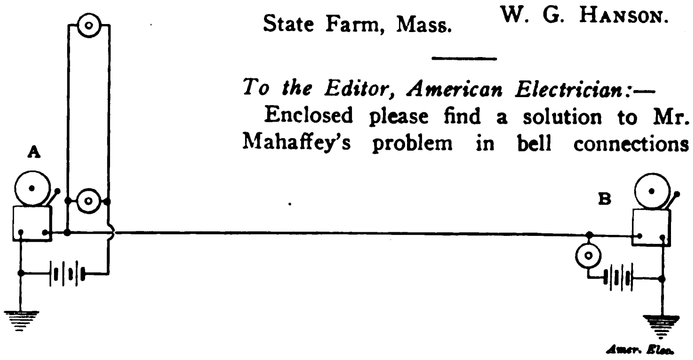


FIG. 4.—MR. GAUSE'S SOLUTION.

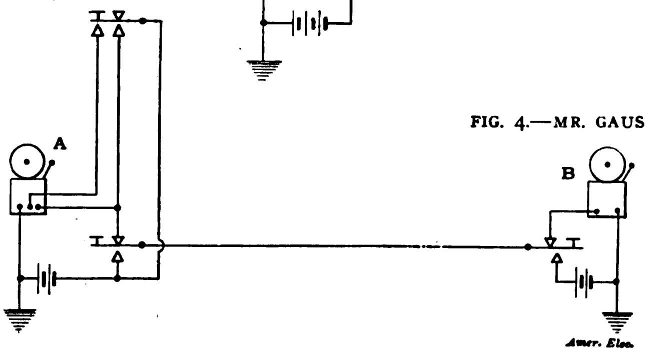


FIG. 3.—MR. HANSON'S SOLUTION.

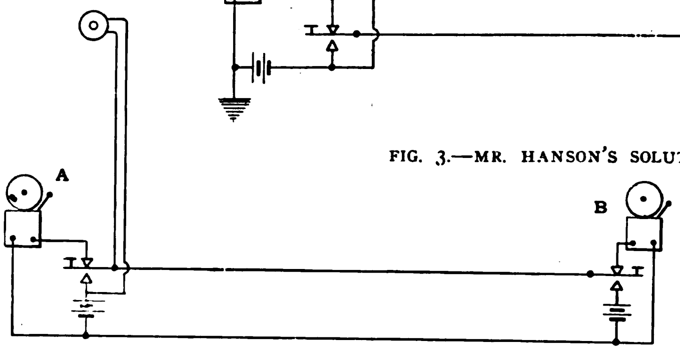


FIG. 2.—MR. LAMB'S SOLUTION.

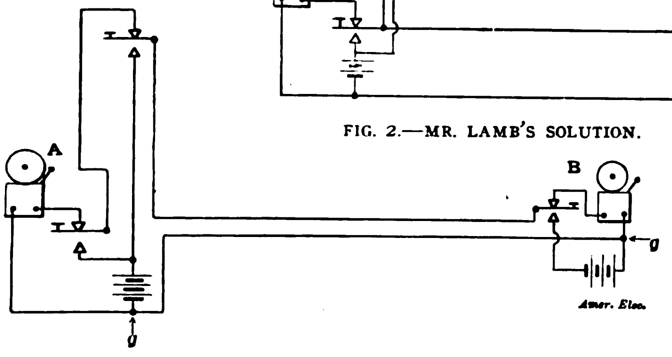


FIG. 1.—MR. PETERSEN'S SOLUTION.

Mr. Mahaffey did not state whether or not a ground return is permissible; if it is, the amount of wire may be reduced, of course, by grounding the two stations at the points, *g, g*, and omitting the lower line-wire.

P. C. PETERSEN.

Washington, D. C.

[The same solution has been sent in by Frederick W. Bender, Elizabeth, N. J.; Frank Carswell, Green Bay, Wis.; H. A. Dresbach, Jersey City, N. J.; H. R. Ern, Chicago; Richard Gessner, Oak Park, Ill.; David Goldblum, New York; P. A. Gould, Saranac Lake, N. Y.; C. H. Hodgkins, Providence, R. I.; C. F. Holmes, Brooklyn, N. Y.; H. Halton, Chicago; R. W. Jackson, New York; H. E. Lane, Philadelphia; J. H. Long, Richmond, Va.; George H. Luft, Highspire, Pa.; J. W. J. Manning, South Boston, Mass.; John J. Marshall, San Francisco; F. V. McAvoy, Floriston, Calif.; Chas. H. Morrison, San Mateo, Calif.; R. E. Noyes, Lincoln, Neb.; G. Peyton, Chicago; F. A. Pim, Los Angeles, Calif.; J. Remey, Buffalo, N. Y.; H. H. Royer, Aurora, Ill.; A. C. Schaedler, Steelton, Pa.; W. H. Shadbolt, Osage, Minn.; L. O. Surles, Chipley, Ga.; F. M. Sutton, Berkeley, Calif.; C. Vanderleith, Brooklyn, N. Y.; E. H. Walters, Waterloo, N. Y., and E. F. Weis, Chicago. It is the correct solution according to the author's diagram, but does not meet the stipulated requirement for the maximum economy in wire, as an inspection of Figs. 2, 4 and 6 will show.—EDITOR.]

To the Editor, American Electrician:—

Herewith I submit a solution of Mr. Mahaffey's problem in bell wiring (Fig. 2). As economy in wire is the chief consideration, I have used two batteries and two double-contact buttons or keys. Depressing either the key or the plain push-button at Station A will ring the bell at Station B, and depressing the key at Station B will ring the bell at A without ringing the home bell.

C. W. LAMB.

Chicago.

[The same solution has been supplied by Chas. H. Dierksmier, Brookline, Mass.; A. R. Treichel, St. Louis, Mo.; Alfred H. Scott and Walter Wynn, of Wilkinsburg, Pa., and H. Wildberger, Jr., Mt. Vernon, N. Y. It involves the peculiarity that one of the push-buttons at Station A rings only the bell at the distant station, while the other push-button rings both the distant and the home bells.—EDITOR.]

To the Editor, American Electrician:—

The enclosed diagram (Fig. 3) is a solution of the bell wiring problem published in your last issue. The two-way keys or buttons normally keep the line closed through the two bells, without battery. Depressing the lower button at Station A disconnects the home bell and connects the battery to the line, ringing the bell at the other station. Depressing the upper key connects the free terminal of the home battery to the line without disconnecting the home bell, and simultaneously short-circuits the vibrator contacts of the bell so it cannot ring. The operation of the two way key or button at Station B is evident from the diagram.

W. G. HANSON.

State Farm, Mass.

To the Editor, American Electrician:—

Enclosed please find a solution to Mr. Mahaffey's problem in bell connections which appeared in the AMERICAN ELECTRICIAN for April. As no restriction in the use of batteries is mentioned, I have used one at each station. Pressing any one of the buttons will connect the free terminal of one of the batteries to the line, putting that battery and the two bells in parallel. The only disadvantage of this method is that both bells will ring when one of the push-buttons is depressed. This was not prohibited, however, in Mr. Mahaffey's statement of the problem.

JAMES H. GAUSE.

Marshallton, Del.

[This solution has also been sent in by Herbert A. Fiske, East Providence, R. I.; L. F. Hammond, New Suffolk, N. Y.; E. S. Lincoln, Brookline, Mass., and J. W. J. Manning, South Boston, Mass.—EDITOR.]

To the Editor, American Electrician:—

The accompanying diagram (Fig. 5) is offered as a solution of Mr. Mahaffey's bell wiring problem which you published last month. The bell connections described by Messrs. McKivitt and Carswell in the March number have been made use of. Depressing either of the two-way keys at Station A will connect the upper line-wire to the home battery and cause the home bell to ring; the vibrator of this bell will also control the distant bell, as the vibrator of that bell is not normally in circuit, while its magnet is. The operation from Station B is the same; the home bell rings and causes the distant bell to ring.

Charlie Potter.

Hoopeston, Ill.

To the Editor, American Electrician:—

The diagram sent herewith (Fig. 6) will, I think, fulfill the requirements of Mr. Mahaffey's letter, published in the April number of the American Electrician.

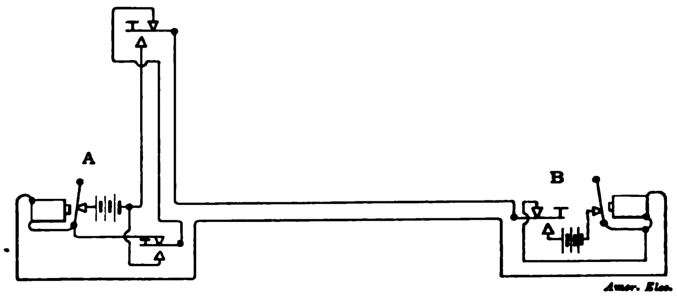


FIG. 5.—MR. POTTER'S SOLUTION.

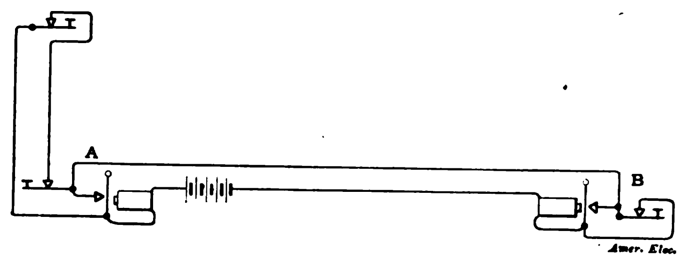


FIG. 6.—MR. SLOCUM'S SOLUTION.

The bells are connected according to the method described by Mr. McKivitt and Mr. Carswell in the March number, and the push-buttons are of the back-contact type. Normally, the magnets of both of the bells are connected in series with the battery, so that a gravity or some other closed-circuit battery must be used. Depressing any one of the push-buttons will remove the short-circuit between the armature and back-stop of the home bell, and that bell will ring; its vibrator will also ring the bell at the distant station, since the magnet of that bell is in circuit and its vibrator is short-circuited by the push-button there. The amount of wire required is about 420 feet.

T. N. Slocum.

Rockford, Ill.

[The same solution was supplied by Charlie Potter, Hoopeston, Ill., as an alternative to Fig. 5.—Editor.]

Size of a 1-Farad Condenser.

To the Editor, American Electrician:—

Referring to page 198 of the April issue, in the middle column near the top, it is stated that the area of a condenser of one farad capacity is 5,555,555,555 square inches or 462,929,293 square feet. This should read 38,580,247 square feet, as 5,555,555,555 ÷ 144 = 38,580,247. I realize that this error does not alter the fact that a condenser of one farad capacity would have to be enormously large, but simply point it out as I believe that you wish to receive the aid of readers in enabling the American Electrician to maintain its high standard of accuracy.

R. Arthur Joslyn.

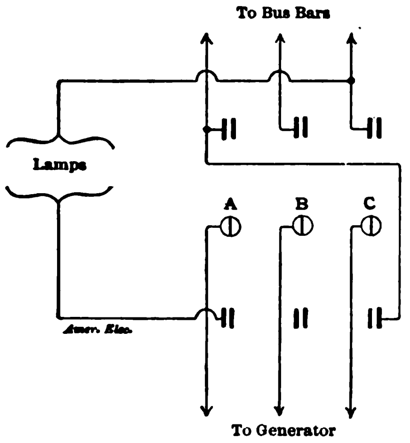
West Lynn, Mass.

[We thank Mr. Joslyn for pointing out the arithmetical error mentioned. It would appear that 12 was used as a divisor instead of 144, which is, of course, the correct one. —Editor.]

Mr. Bailey's Excess Voltage.

To the Editor, American Electrician:—

Referring to Mr. Bailey's synchronizing voltage (page 162, March, 1904) I would suggest that the reason he gets more than the generator voltage is that the two generators are in series; consequently, when they are out of phase, he gets the vector sum of their voltages. In this connection, it may be of interest to point out that synchronizing lamps may be connected up so as to enable one to "synchronize bright" instead of dark, without the use of transformers. The accompanying diagram shows how the connections should be made to obtain this result. The lamps must be capable of taking about double the voltage of the generator.



CONNECTIONS FOR SYNCHRONIZING.

A. E. Ecklund.

Pittsburg, Pa.

[Mr. Ecklund's letter was received before the April number of this paper was issued, but too late for insertion in that number.—Editor.]

Thawing Frozen Water Pipes.

To the Editor, American Electrician:—

In the April issue of the American Electrician Mr. Walter M. Petty states that the idea of thawing frozen water pipes electrically was first suggested in 1900, but was not, so far as he was aware, put to practical use until this year. Many water pipes were thawed in this manner in the upper Mississippi valley during the winter of 1898-99. The method was practically identical with that described by Mr. Petty. The idea originated, as I remember, with Prof. D. C. Jackson, of the University of Wisconsin. In spite of the fact that pipes are usually placed six feet under the surface in this section the trouble was so prevalent that winter that Prof. Jackson and others of the engineering staff at Madison volunteered to instruct electric light superintendents in the work. Later on it was claimed that many leaks developed at pipe-joints, caused by damage from the current.

D. P. Wallihan.

Osage, Iowa.

To the Editor, American Electrician:—

The method outlined by Mr. Petty in the April number of the American Electrician, of thawing frozen water pipes, was, with a few unimportant differences in minor details, used by me in the winter of 1900-1901, in the town of Durham, N. H. About 1000 feet of galvanized iron pipe, including service and main, had been frozen up for six weeks, and local plumbers had given up the job of thawing out as hopeless; where they had dug down to the 1½-inch main, the ice completely filled the pipe.

The apparatus used consisted of one 100-light G. E. oil-cooled transformer, one 100-light and three 20-light Stanley transformers, all connected in multiple, and transforming from 2400 volts to 55 volts. An ammeter, volt-meter and water-barrel rheostat were in the secondary circuit, the whole outfit being installed on an express wagon. Primary taps were made midway between secondary hitches. The secondary connections were made at cellar entrances of service pipes by means of split copper sleeves. The current used varied from 300 to 500 amperes, and in all but the shortest runs (straight across the street from cellar to cellar) the rheostat plates were short-circuited, the volt-meter reading from 40 to 50 volts. This low reading was probably due to the heavy over-load on the transformers. The time required to start water varied from five to twenty minutes; the longest run was about 300 feet, consisting mostly of 1½-inch main.

Arthur Thurston.

Hooksett, N. H.

Queries and Answers

IMPORTANT. No attention will be given to any inquiry which does not give the full name and address of the inquirer.

What is the advantage of using two lamps in series on a 235-volt circuit instead of one lamp of the full voltage? W. G. B.

Lamps of 117 volts rating can be made more efficient than 235-volt lamps.

Please give the formula for calculating the dimensions of an induction coil to give a certain length of spark. G. W.

There is no such formula so far as we know. The dimensions and windings of induction coils are determined empirically from experimental data.

What change would be necessary in an automatic cut-off engine to make the governor cut off at ½ stroke instead of ¼ stroke, and thereby obtain more power from the engine? H.

No change in the engine is necessary. Simply put on the load that it is rated to carry at ½ stroke cut-off and the governor will change the cut-off automatically; that is what it is there for.

Are shunts practical for use with voltmeters? H. M.

Certainly not; a resistance connected in parallel with a voltmeter will not affect the difference of potential at its terminals unless the resistance is so low as to disturb the circuit being measured and cause it to have an e.m.f. different from the one which it is desired to ascertain.

Is there any reason why the gasoline engine described in the February number cannot be built by anyone: I mean any such reason as patents or other restraining conditions? J. M. K.

No; any of the apparatus described in our columns for the purpose of enabling readers to build it may be made for personal use without hindrance, and all except the induction motors may be built to sell if one chooses to do so.

What is the formula for determining the size of wire to use in a three-wire circuit G. R.

The same as the formula for a two-wire circuit, applying it to the outside wires of the system. For the neutral wire a formula is not ordinarily used; the wire is made equal in cross-section to each of the outside wires in most isolated plant work, and of about one-half the cross-section of each outside wire in circuits to be supplied from a three-wire central station.

Please give formulas and instructions for changing the gasoline motor described in the February number from 6 horse-power to 10 or 15 horse-power. A. H. B.

The motor cannot be enlarged by means of any simple formulas; if all of the relative proportions of the 6-h.p. motor are observed in working out the larger machine, the cylinder dimensions may be roughly approximated by applying the maxim that the output is approximately proportional to the product of the cylinder diameter and the square root of the length of the stroke.

A series-wound motor of ¼ horse-power runs at about 2000 r.p.m. at full load, and shows normal heating, etc.; when connected up as a shunt motor the speed comes down to about 1400 r.p.m. and the machine gets very hot; why is this? J. F.

Because the current in the field winding is much greater when it is connected across the circuit than when it is connected in series with the armature, so that the field is very much stronger and the heat produced in the winding is very much greater.

Why does a direct-current constant-potential arc lamp require a "steadying" resistance in series with it? C. M. H.

Because the resistance of the arc decreases with an increase of current, so that any slight increase of current produced by the mechanism would be greatly exaggerated by this property of the arc and cause unstable operation. The resistance of the wire coil *increases* with an increase of current and compensates for the peculiarity of the arc.

What is the character of the current generated in the armature conductors of an induction motor? (2) If it is alternating, what is the relation between its frequency and the primary frequency? (3) Is it practical to vary the speed of an induction motor through a range of 3 or 4 to 1 by means of resistance in the secondary? C. E. F.

Alternating. (2) The frequency in the rotor conductors is proportional to the "slip"; in other words, it is equal to the primary frequency minus the product of half the number of poles and the actual rotor speed in revolutions per second. Thus,

$$f'' = f' - 0.5 \text{ poles} \times \text{r. p. s.}$$

(3) It is possible but not very practical on account of the low power factor and efficiency that result.

What effect does a condenser produce when connected across the contacts of the vibrator of an induction coil? (2) How does the twisting of armature discs on the shaft, so as to "spiral" the slots, prevent humming in a direct-current dynamo or motor? (3) When a single-phase induction motor is started by means of a phase-splitter and then left to run as a purely single-phase machine, why does it continue to run? J. W. J. M.

It affords a path for the discharge of the primary winding when the contacts separate, so that the discharge does not pass across the contact gap, thereby preventing the destruction of the contacts; it also expedites the discharge and thereby makes the demagnetization of the core more sudden and the induced e.m.f. consequently greater. (2) By causing the teeth to enter and leave the edges of the magnetic field gradually instead of suddenly. (3) Because the reaction of the rotor upon the stator produces a rotating field like that of a polyphase machine.

According to the rules of the American Power Boat Association, the horsepower of an engine is computed by the formula

$$\text{H. P.} = \frac{A \times N \times S}{K} \times r.p.m.,$$

in which A = piston area in square inches, N = number of cylinders, S = stroke in feet, and K is a constant. Can this formula be used in designing an engine? (2) It is stated in several text-books on steam and gas engines that it is common practice to make connecting rods two or three times the length of the stroke or four to six times the throw of the crank. The two statements are contradictory; which is correct? (3) What form of reciprocating engine will give the least vibration? G. G. J.

It can be applied if one has appropriate values for the constant K to meet different conditions. (2) The statement should read: "Two to three times the stroke or four to six times the *length* of the crank." (3) Theoretically, a multi-cylinder engine with the cylinders arranged equi-distantly in a circle with their axes radial to the crank shaft.

Why does an induction motor take so much more current when the impressed e.m.f. is reduced one-half than when it is normal? (2) What is the relation between the impressed e.m.f. and the current for a given load? (3) How does the change in impressed e.m.f. affect the speed? (4) Why does the torque of such a motor vary as the square of the impressed voltage? (5) Why cannot shunted ammeters be used for alternating-current work? A. S.

Because the power of the motor is approximately proportional to the product of current and voltage; therefore, if the voltage is reduced the machine must take more current to do the same work. (2) The output is equal to $E\,I\,p\,(1 - s)$, in which E is the impressed e.m.f., I is the current, p is the power factor and s is the slip. (3) The speed will remain approximately the same as at normal voltage. Since it depends upon the frequency and the slip, the only change will be that due to a slight increase in slip. (4) The torque is proportional to the strength of the magnetic field × the current in the rotor conductors. The strength of the field varies inversely as the voltage and the current in the secondary conductors varies directly with the field. Consequently, the torque varies as the square of the field and therefore inversely as the square of the voltage. (5) They can be and are used for such work.

In the formula for transformer windings, why is the counter e.m.f considered equal to the impressed primary e.m.f.? (2) If the two are equal, how can any current pass in the primary windings? (3) What is meant by the "synchronous speed" of a motor? (4) Is it true that two-path armature windings are not suitable for large generators; if so ,why? M. J. McA.

Because the two are so nearly equal that the difference is negligible. (2) The counter e.m.f. due to the cutting of the magnetic flux across the wires is not precisely opposed in phase to the impressed e.m.f. (3) The speed at which the rotor of an induction motor would revolve if there were no "slip"—if it kept up with the rotating magnetic field. A motor never runs at synchronous speed unless driven by some other power than its current, because at that speed no current would be induced in the rotor conductors, and it is this current that makes it run. (4) Yes. Because a two-path winding gives best results with only two sets of brushes (one positive set and one negative set), and in order to obtain sufficient area of contact surface between the brushes and the commutator with two sets of brushes the commutator would have to be made very long and correspondingly expensive; long commutators are also very difficult to build substantially.

1500-KILOWATT ALTERNATOR FOR ST. LOUIS.

The central power plant at the St. Louis Exposition will contain some highly interesting engines and generators, built especially for this occasion and embodying the very latest engineering practice. Among these will be included a slow-speed alternating-current generator built by the National Electric Company, of Milwaukee, and direct driven by a Hamilton Corliss vertical cross compound engine of 2250 horsepower, built by the Hooven, Owens, Rentschler Company, Hamilton, Ohio.

The National alternator will be rated at 1500 kilowatts and will be driven at 83 r.p.m. It will deliver current at 25 cycles and 6600 volts for various purposes about the Exposition grounds. Like all standard alternators built by the National Electric Company, it is of the revolving field type. The revolving field magnet is of large diameter giving additional fly-wheel effect to the engine, and the construction of the field coils is said to make them practically indestructible. All parts are accessible, and the machine is thoroughly ventilated.

The field magnet is made of cast steel in halves, and these are bolted and secured together by shrunk links. The rim of the wheel, to which the cast steel pole-pieces are bolted, is of channel cross section. The field coils comprise 65 turns of 1½ x ⅛-in. copper strap, wound on edge and thoroughly insulated, the outer edge of the coil being exposed to the atmosphere for cooling. Laminated pole shoes are secured to the ends of the pole pieces, and serve to hold the field coils in position. These shoes cover a large polar arc, and distribute the magnetic flux evenly.

The field coils are insulated from the pole-pieces by fuller board, and from the pole-shoes and spider ring by heavy fibre. The revolving field is 16 ft. in diameter at the pole-faces and weighs approximately 50,000 lbs.

The frame is a circular cast-iron housing into which laminated punchings with inwardly projecting teeth are assembled, for the reception of the armature windings. The frame is extremely heavy and stiff, not requiring any external support; it is divided horizontally, the halves being firmly bolted and keyed together. The bolts and keys are contained entirely within the cross section, obviating the use of side lugs. Large open spaces are provided in the sides of the frames, allowing a free passage of air from the ventilating ducts in the core.

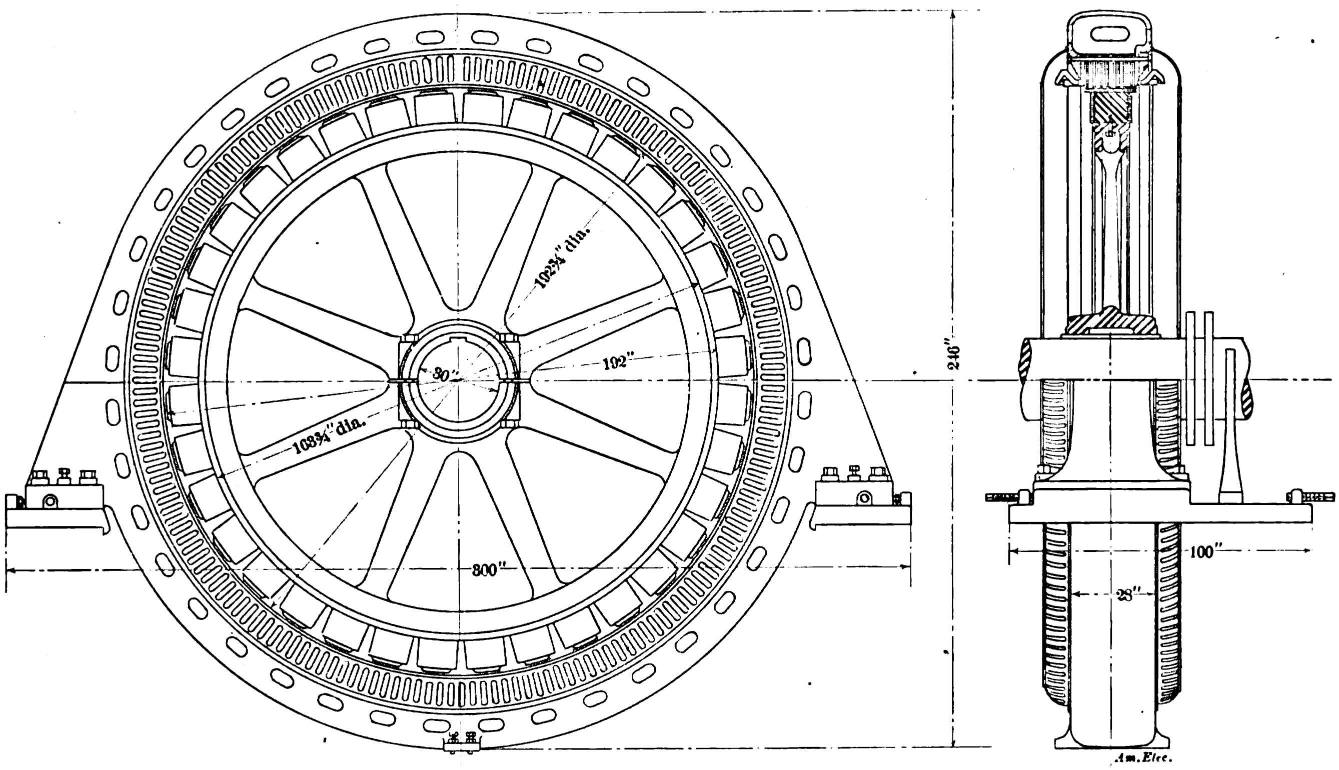


FIG. 1.—ELEVATION AND END VIEW OF 1500 KW. NATIONAL ALTERNATOR.

The armature core is built up of laminated soft steel punchings, which are annealed and japanned before assembling, and ventilating space blocks are inserted at suitable intervals, providing openings extending around the circumference and allowing a free passage for the heat generated in the windings. There are six slots per pole, each 2½ ins. deep x 1½ in. wide, and containing 14 conductors of 0.37 x 0.28 in. compressed copper strand. The internal diameter of the armature is 16 ft. ¾ in. and the axial width of the core 16 ins. Cast-iron collector rings and carbon brushes are used, enabling the machine to be operated with a minimum amount of attention, and this construction also provides a collector gear which will carry a heavy temporary overload.

The net weight of this alternator is 135,000 lbs., and the following are the guarantees for it: Efficiency at 1¼ load 95.5 per cent; at full load, 95.5 per cent; at half load, 94.75 per cent. Regulation, 5.5 per cent on a power factor of unity, and 22 per cent a power factor of zero. The temperature rise is not to exceed 30° on the armature and magnets on a continuous run at full load and 40° on the armature and magnets on a continuous run at 25 per cent overload.

◆◆◆

"DELTABESTON" MAGNET WIRE.

An insulated wire which is said to be practically indestructible, and hence especially adapted for armature, field and magnet coils, has been brought out by the D. & W. Fuse Company, of Providence, R. I. This wire, which has been given the name of "Deltabeston," is insulated with practically pure asbestos which has been treated in such a manner that its insulating properties are said to be exceptionally good. It is claimed that its resistance to heat renders it absolutely indestructible so far as any temperature rise to which it may be subjected in commercial service is concerned. Investigation has shown that at a temperature of about 147° C. cotton-covered wire will in time char to an extent that will break down its insulation. It was further ascertained that at 199° C. cotton-covered wire began to smoke in 20 seconds. At 239° C. it was distinctly discolored in 50 seconds and complete carbonization had taken place at 245° C. in 2 minutes and 15 seconds. Deltabeston, the manufacturer says, has been run at a dull red heat representing a temperature in the neighborhood of 600° centigrade without its insulation being destroyed. The company has given the wire severe tests, having had a large number of railway motors in service equipped with it, and the results have been so satisfactory that entire motor equipments are being gradually rewound with it. Deltabeston is made in sizes from No. 4 to No. 18 B. & S. gauge.

◆

HIGH TENSION WALL INSULATOR.

In bringing high-tension lines into stations through the walls of the building it becomes a serious question how best to insulate the wires from grounding. In some cases the line is brought through a hole in the wall; in others, through an elaborate system of tubes placed in the wall; in others through a piece of insulating material of some kind set in the wall; in others, the line enters through an elaborate tower built for the purpose on the top of the building; in still others it is taken directly through the roof of the building.

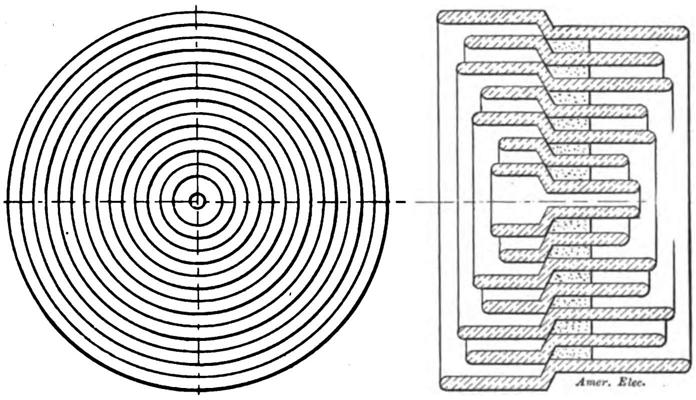


FIG. I.—HIGH TENSION WALL INSULATOR.

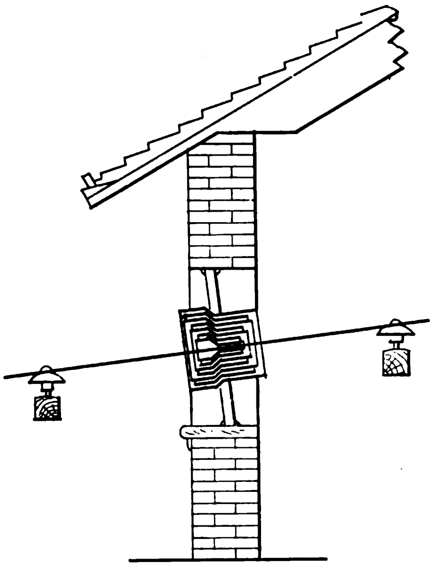


FIG. 2.—WALL INSULATOR IN PLACE.

It is manifestly impossible to prescribe any fixed method for all voltages and locations since this will depend upon a number of conditions. The requirements, however, that must be met are: The maintenance of proper insulation of the circuit; the prevention of the entrance of rain, snow, cold air and dust; the proper mechanical fastening of the line wire, and reliability and simplicity of construction.

In general, wires are best brought through the wall of the building. For high voltages a long insulating tube of small diameter and very heavy wall may be placed over the wire and passed through a slab of insulation set in the wall of the building, the whole being protected from driving rain by an extension of the roof. The insulating tube slopes downward and some form of drip point is provided on the wire just outside the end of the tube. This form of construction has been successfully used for potentials as high as 60,000 volts; but the chief difficulty has been to secure the proper insulating tubes, owing to the fragile nature of porcelain and glass, especially when only one tube is used.

The Locke Insulator Manufacturing Company, of Victor, N. Y., has brought out the appliance shown by Fig. 1 herewith as a solution to the problem. This, it will be noted, is a sort of elastic affair, and can be built up of as many concentric tubes as may be necessary for the insulation of the voltage used. The maker claims that this nest of tubes when cemented together is very strong and substantial, so that fragility is not a part of its nature, and one of the objections lodged against insulators for the purpose under discussion, is overcome. The material used in its construction is a special mixture of clay claimed to withstand high working voltages, so that it combines insulating merit as well as strength. The method of mounting the insulator in the wall of the building is clearly shown in Fig. 2.

INSTRUMENTS FOR DETERMINING INDUCTION CONSTANTS AND ENERGY LOSSES OF ALTERNATING-CURRENT APPARATUS.

BY OUR BERLIN CORRESPONDENT.

A very handy measuring apparatus intended for ascertaining the constants controlling the behavior of alternating-current apparatus has just been brought out by the Siemens & Halske Co., Berlin. As these constants, namely, of self-induction, mutual induction, capacity, and eddy-currents and hysteresis losses, are generally dependent on the number of cycles of the alternating current, measurements should best be made with alternating current, and of the proper frequency. For this purpose the two bridge arrangements represented in Figs. 1 and 2, have been devised. The former measures inductances down to 0.001 henry, while the bridge shown in Fig. 2 has a range of 0.001 to 0.0000001 henry. Both instruments are connected up as shown in Fig. 3, representing a modified Wheatstone bridge. The branches *a* and *b* consist of a manganin wire, divided into the two branches by a sliding contact; the branch *B—C* comprises a self-induction and resistance standard and the branch *A—C* contains the inductance *Lx* to be measured (the resistance of which is *Rx*), and in addition a resistance box *r*. The points *A* and *B* are connected to a source of alternat-

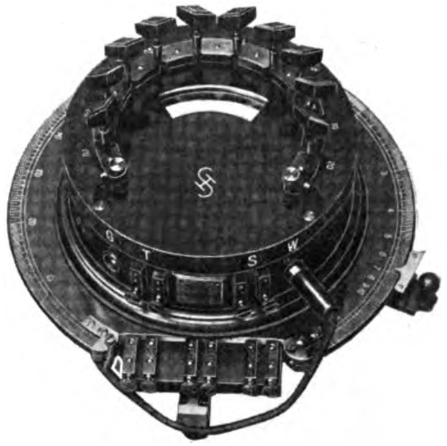


FIG. I.—APPARATUS FOR MEASURING INDUCTANCE.

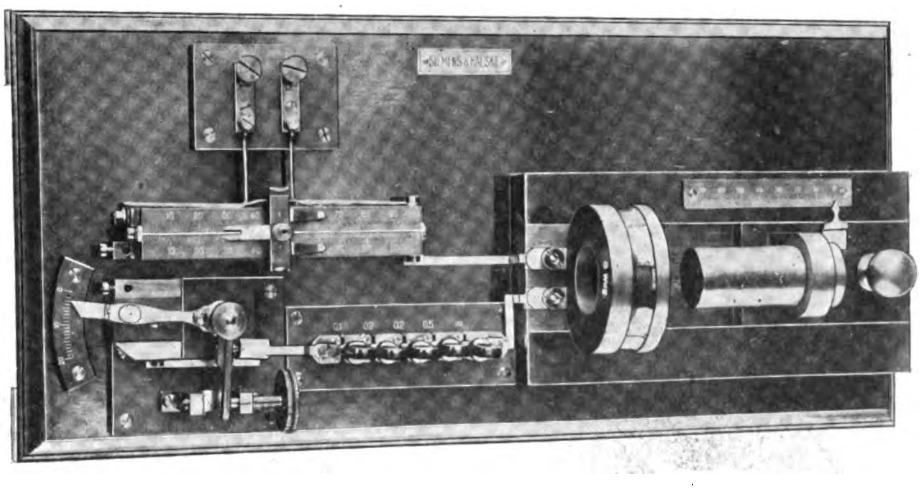


FIG. 2.—APPARATUS FOR MEASURING INDUCTANCE.

ing current following the sine law as nearly as possible, and in the sliding-contact branch an ordinary telephone receiver is inserted. When the sliding contact touches the manganin wire at such a point that no sound is heard in the telephone, the relations

$$\frac{Rx + r}{R} = \frac{a}{b} \text{ and } \frac{Lx}{L} = \frac{a}{b}$$

will enable the inductance Lx to be determined.

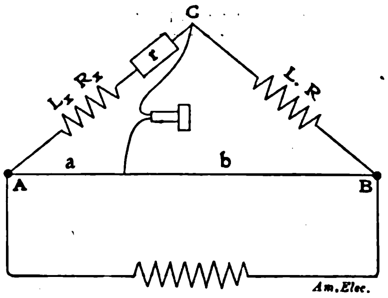


FIG. 3.

When direct current is applied to the bridge, after the above alternating-current adjustment has been made, and the telephone is displaced by a galvanometer, the latter will indicate in the bridge wire the presence of a current which by shifting the plugs in the resistance box r may be made to disappear. This resistance, r, which is finally inserted, represents the resistance loss, and multiplying it by the square of the current gives the watts lost in the tested apparatus by hysteresis, eddy currents, radiation, etc.

As regards the alternating-current source, which in order to obtain a sharp minimum in the telephone should yield a sine-wave current as pure as possible, this is obtained by the use of a special transformer or induction coil and a high-frequency generator, the former producing alternating current of 300 to 650 cycles per second and the latter, a current of frequencies up to 10,000 cycles per second. Fig. 4 is a diagram of the transformer, and Fig. 5 is a view of the actual apparatus. To the center of a circular telephone diaphragm, D, a sack of carbon granules is fixed, the lower part of which rests on a stationary support; this forms the equivalent of a highly sensitive telephone transmitter, or microphone. A tubular permanent magnet, M, surrounds the microphone and one end is in close proximity to the diaphragm, the distance between the two being adjustable. The steel tube carries a coil which is connected in series with the secondary coil, S, of a small induction coil and the external circuit. The primary coil P of the induction coil is connected in series with the microphone and a few storage battery cells, B, in a local circuit, as shown. When this circuit is closed, the diaphragm vibrates at a high rate under the influence of the microphone and the exciting coil in the secondary circuit of the induction coil, in the well-known manner.

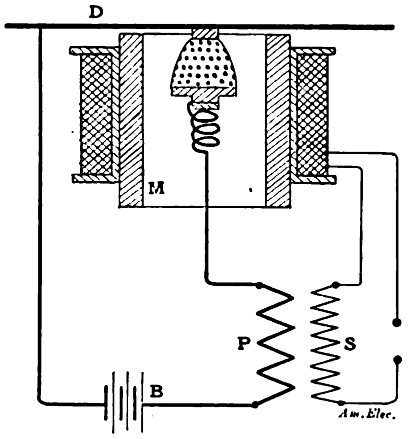


FIG. 4.—DIAGRAM OF TRANSFORMER CONNECTIONS.

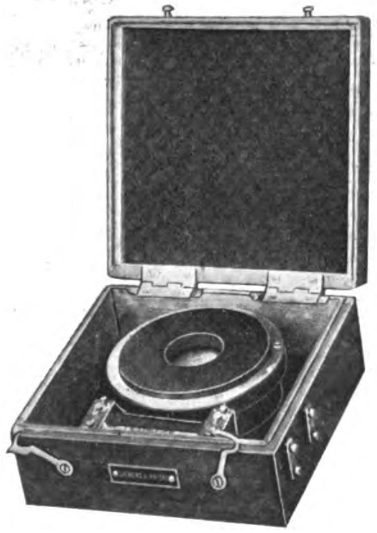


FIG. 5.—TRANSFORMER.

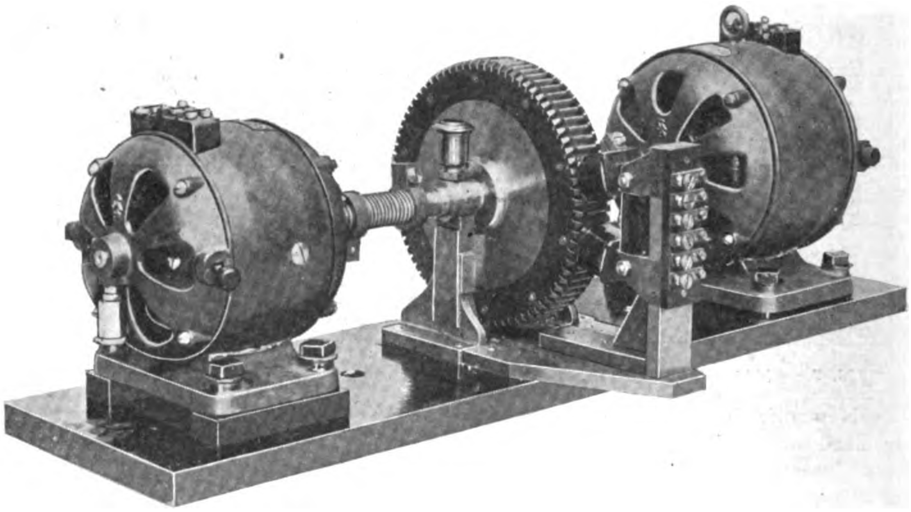


FIG. 7.—HIGH-FREQUENCY GENERATING OUTFIT.

The frequency of the current delivered by the "humming" transformer or induction coil is determined by means of the apparatus illustrated in Fig. 6. This consists of a closed tube, the lower end of which carries a sensitive telephone receiver which is attached to the tube so that all the sound waves produced by the vibrations of its diaphragm are delivered within the tube, and a smaller telescoping tube adjustable within the upper end of the main tube and carrying a flexible ear tube at its outer extremity. The main tube is provided with a graduated scale, which is calibrated so as to read directly in cycles per second. The telephone receiver is connected to the secondary circuit of the "humming" transformer and the listening tube applied to the operator's ear; the telescoping tube is adjusted until the sound is at its maximum, when the index on the graduated scale shows the frequency of the current.

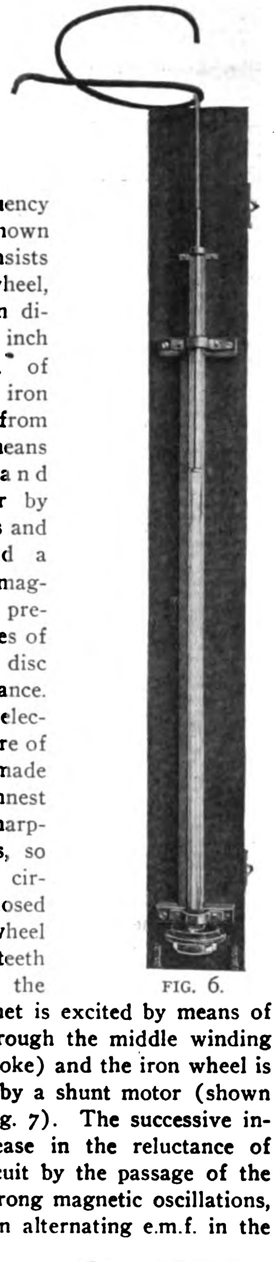


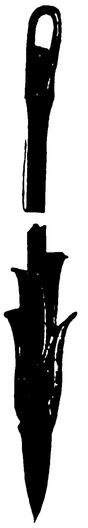
FIG. 6.

The high-frequency generator is shown in Fig. 7. It consists of a toothed wheel, about 8 inches in diameter and 13-16 inch thick, composed of very thin sheet iron discs insulated from each other by means of varnish and clamped together by hard rubber rings and metal discs, and a laminated electromagnet with its poles presented to the edges of the teeth of the disc at a small distance. The poles of the electromagnet, the core of which is also made from the thinnest sheet iron, are sharpened like wedges, so that its magnetic circuit is almost closed by the iron wheel whenever two teeth are in front of the poles. The magnet is excited by means of direct current through the middle winding (on the magnet yoke) and the iron wheel is revolved rapidly by a shunt motor (shown on the left in Fig. 7). The successive increase and decrease in the reluctance of the magnetic circuit by the passage of the teeth produces strong magnetic oscillations, which generate an alternating e.m.f. in the secondary coils on the magnet poles. The dynamo shown on the right in Fig. 7 is connected to an adjustable resistance and serves to give the motor a steady load, so as to have a constant rate of revolution.

New Apparatus and Appliances

A NEW GUY ANCHOR.

Crouse-Hinds Co., of Syracuse, N. Y., is manufacturing the simple guy anchor shown by Fig. 1 herewith. The anchor is made of forged steel and weighs 22 pounds. The rod is one inch square and five feet long, one end being flattened and pointed, then twisted one-quarter way round. Four wings, each 8 ins. long, 1½ ins. wide and ⅜ in. thick, are riveted on the flattened part, two above the twist and two below. The wings are riveted in such a manner that when open, each wing forms an angle of 90° with the next wing. During installation the wings are closed around the rod; but when an attempt is made to pull the rod out of the ground, the wings, owing to their shape, spread out and offer a wide area of resistance to any further pull. The anchor makes a four-inch hole when being installed, and the only tool necessary for its installation is a sledge hammer. The anchor can be driven in any kind of soil, and a welded ring, to which the guy wire may be fastened, is provided in the end of the rod.



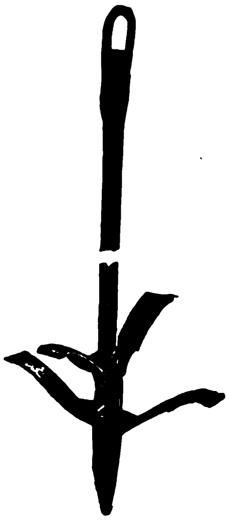


FIG. 1.—GUY ANCHOR.—FIG. 2.

KEELER WATER-TUBE BOILER.

The Keeler water-tube boiler, built by the E. Keeler Co., of Williamsport, Pa., is of the box header type, having a horizontal steam and water drum. The steam outlet is placed in the center of the drum, and is provided with a large-sized dry pipe or separator, while the added flexibility resulting from the long rear header allows for expansion and contraction of the tubes. These are straight and inclined one inch to the foot. The headers are eight inches deep inside, and the throat covers one-half of the circumference of the drum, which is reinforced at this point by three bridges of plate and by the throat flanges. All drums above 36 in. in diameter have triple-riveted double butt-strapped straight seams. There being nothing to impede the rapid circulation of the heated water up through the front header and the cooler water down through the rear header and up through the tubes, the circulation ought to be such as to recommend the boiler for economy and durability. In construction, the wrapper sheet is flanged, this process being patented by the Keeler Company. The boiler is of wrought steel throughout, no cast iron or cast steel being used except for the handhole plates. All the handhole plates are faced in a special machine, and the joint with the header packed with a special rubber composition or metallic gasket. The feed pipe entering the front drum head is carried back into a mud drum. A blow-off pipe is connected to the back end of the mud drum and extended through the rear head of the steam and water drums, whence it can be connected to the main blow-off pipe or left with a separate outlet so the character of the impurities in the feed water can be determined. The front end of the boiler is hung from two heavy channels which rest on wall plates. The rear header rests on expansion plates, thus giving a flexible setting. The front is of sheet steel, with cast-iron doors and frames, and is sectional so that mechanical stokers can be installed without change in construction. The rear header is completely enclosed. An angle-iron frame and sheet-steel tube door are provided for the rear setting wall. Cast-iron side cleaning doors are provided and the cleaning openings so arranged that no cold air is admitted, while if desired the holes in the staybolts are made large enough for the use of a steam blower in front. These boilers are built in units from 50 to 675 horse-power, and also in special sizes to suit space conditions. The standard boilers are built for a working pressure of 150 pounds, but if desired can be built for any pressure up to 250 pounds. The grate surface is carefully proportioned and air space regulated by the class of fuel to be burned.

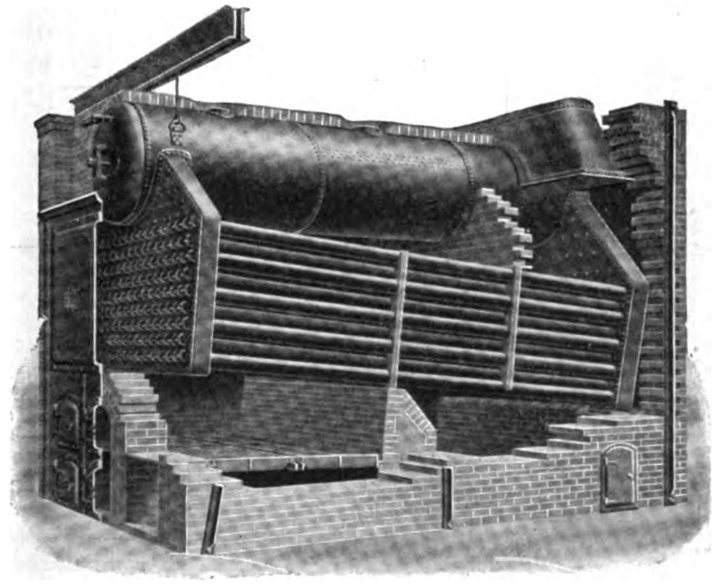


FIG. 3.—KEELER WATER-TUBE BOILER.

IMPROVED "HYLO" INCANDESCENT LAMP.

The Phelps Company of Detroit, Mich., has brought out an improvement to their "Hylo" lamp which is shown in Fig. 4 herewith. It will be remembered in this connection that originally the "Hylo" lamp was provided with a spring base so that when screwed tightly into the socket one filament was in circuit, and when slightly unscrewed the other filament was in circuit. The manner of obtaining these results was open to objection, owing to the looseness of the lamp in the socket. The objection was subsequently overcome by giving the lamp a firm seat in its socket and making the connections to the baby filament and full candle-power filament through the medium of a small double push switch attached to the lamp by flexible cord. In the form now being brought out, three wires run to a small switch as shown by Fig. 4. One wire is attached to the pivot of a switch blade and each of the other two wires is connected to a small copper contact strip which is wiped by the switch blade in pass-

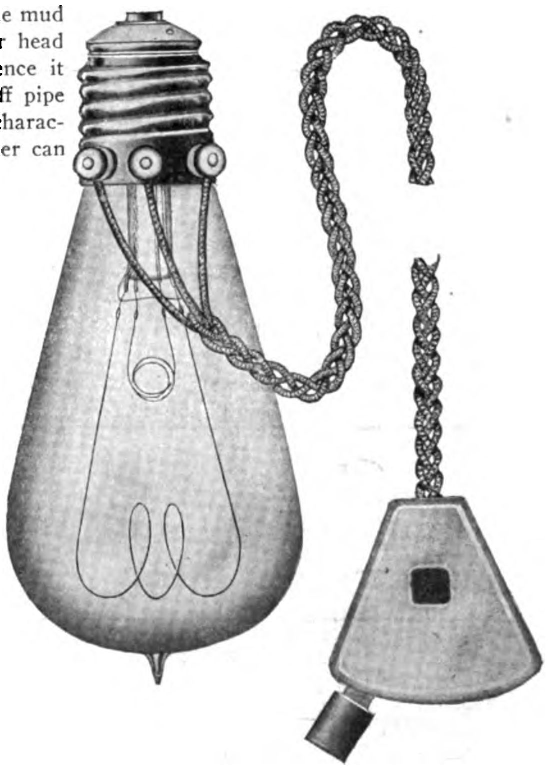


FIG. 4.—"HYLO" INCANDESCENT LAMP SWITCH.

ing. In this way, the switch is first in the off position, a move to the next position places the 1-c.p. filament in circuit and a further movement places the 16-c.p. filament in circuit. The whole arrangement is enclosed in porcelain, carefully designed to meet the Underwriters' requirements.

TRUMBULL PANEL CUTOUT.

Fig. 5 herewith shows a 15-ampere, 110-volt panel cutout brought out by the Trumbull Electric Manufacturing Company, of Plainville, Conn. The particular advantage claimed for this cutout is the fact that it can be used for either the two or the three-wire system and for any number of circuits. Fig. 6 shows three panel cut-outs in a panel box, with connections for two-wire and three-wire systems indicated. In the former, both wires go up one side and continuing over go down on the other, while in the three-wire system, the neutral wire goes up on one side and crossing over goes down on the other, the outer wires terminating at the top. The manufacturer calls attention to the fact that any size of panelboard can be made up from stock with the aid of these cutouts. The individual panels are 3 in. by 6 1-16 in. and when arranged in the box would take up 12⅛ ins. Each additional circuit would therefore add 3 ins. to the length of the box. Each panel includes both switch and cutout, and when used with enclosed fuses conforms to the underwriters' requirements.

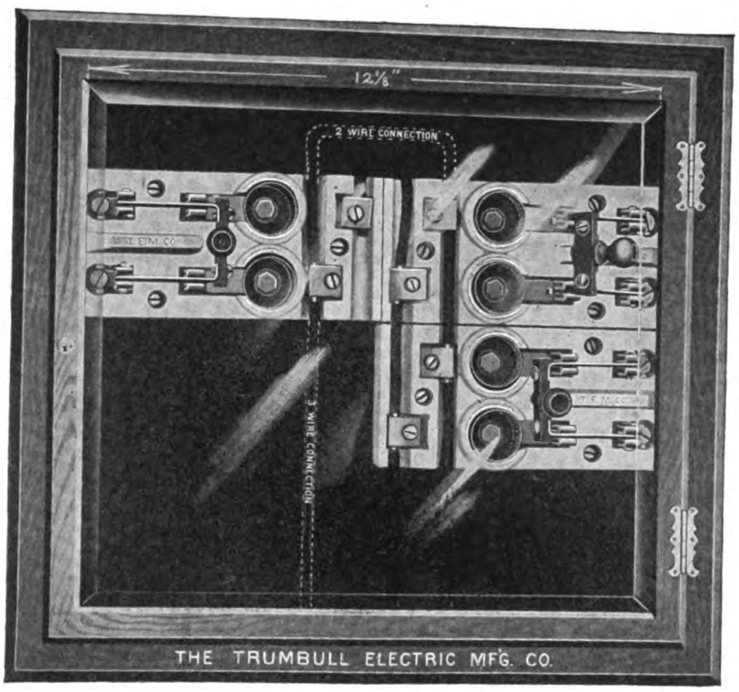


FIG. 6.—TRUMBULL PANEL BOX.

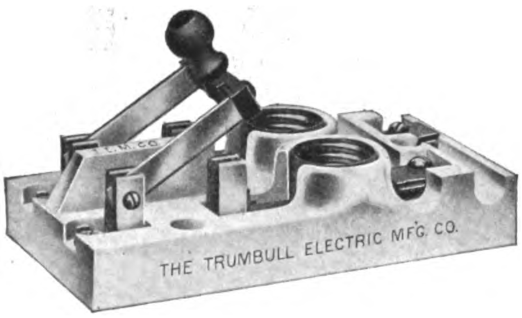


FIG. 5.—PANEL CUTOUT.

MONARCH INCANDESCENT LAMP.

Fig. 7 herewith shows the "Monarch" lamp made by the Monarch Electric Manufacturing Company, of Warren, Ohio. This is simply an improved incandescent lamp adapted for use in any standard socket. The lamps are made in two sizes both for use on either alternating or direct-current circuits. No. 1 has a round bulb 5 in. in diameter and No. 2 has a round bulb 3¾ in. in diameter. The bulbs are sand-blasted so as to give them a frosted appearance, and the voltage range of the lamps is from 90 to 125 and from 200 to 250. The No. 2 is a 25 candle-power lamp and the only fixture that is necessary for use on any standard socket is a polished aluminum reflector finished in dead black on the outside. The No. 1 is a 55-c.p. lamp and is used the same as No. 2 except that for purposes of ornamentation it has a brass or oxidized copper collar fitted with a spring which holds the reflector in place. The lamps are also provided with a ceiling fixture adapted for keyless sockets. The lamp is furnished in two efficiencies corresponding in life to 3.5 and 3.1 watt lamps, their life tests showing, it is said, 600 to 800 hours run. The lamp is equipped with a ventilated collar which is said to prevent overheating and also to prolong the life of the lamp. The reflector of the lamp does not come in contact with the bulb and thus allows of a free circulation of air. The current consumption of the No. 1 lamp the manufacturer says is 120 watts. The current consumption of the No. 2 lamp is the same as the ordinary 16-c.p. lamp but by the use of the reflector it is rated at 25 candle power.

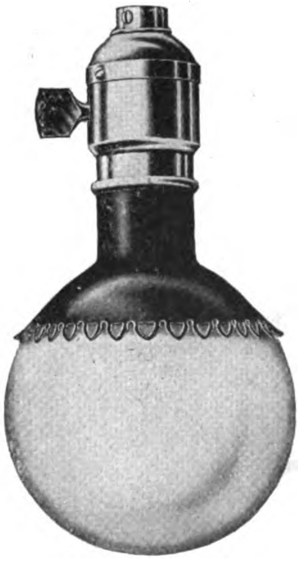


FIG. 7.—MONARCH INCANDESCENT LAMP.

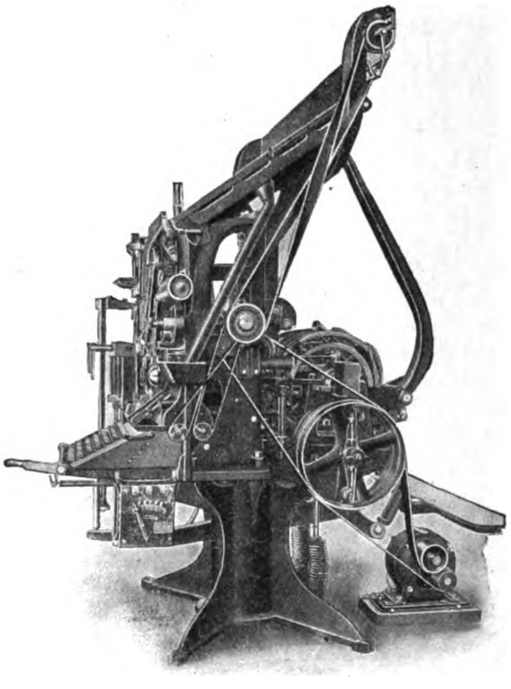


FIG. 8.—MOTOR-DRIVEN LINOTYPE MACHINE.

APPLICATION OF SMALL MOTORS.

The accompanying engraving, Fig. 8, illustrates admirably the fine adaptability of small "protected type" motors to individual driving. The case in point is that of the well-known linotype Mergenthaler machine, and it is driven by a Watson motor, built by The Mechanical Appliance Company, Milwaukee, Wis. The motor is equipped with an idler pulley journaled on an axle which is fastened to the field magnet frame; this arrangement, of course, causes the belt to hug more of the circumference of the motor pulley than it otherwise would and permits the motor to be set close up to the driven machine without entailing belt slippage. The Watson motor, being very compact in design and almost entirely enclosed, is especially well-adapted to applications of the class here shown. The machine itself has been described in our columns very fully and our readers will doubtless remember its construction. The lubrication and brush feed are, of course, entirely automatic, so that the machines need only to be started up and shut down, with an inspection at long intervals to see if the brushes need renewal or the oil well refilling. One of the principal features of the equipment is a special starting box, through which a 20 per cent. variation in the speed of the motor can be obtained.

MILNE WATER-TUBE BOILER AND SUPERHEATER.

The accompanying illustration shows a sectional elevation of the Milne water-tube boiler and also of the superheater connected to the boiler. The boiler is constructed of wrought steel throughout and does not contain any flat, stayed or inaccessible surfaces; all surfaces being cylindrical, of moderate diameter, and accessible through one man-hole. The boiler is a simple combination of four parts; an upper and a lower drum connected by a number of sections of 4-in. seamless drawn steel tubes, to which is coupled an independent feed-water section composed of a single row of tubes. The tubes are staggered and are all curved to a five-foot radius. There are five different bends in a complete set of tubes and the front and the back rows are interchangeable. The feed-water section extends across the back of the boiler, the upper ends of the tubes being expanded into an independent header which receives the feed-water. The furnace is designed with a view to obtaining the most efficient combustion. A fire-brick arch covers the furnace in such a manner, the manufacturer says, as to maintain the high temperature required to ignite and burn the fuel gases, and as the heating surface is situated at the back of the furnace and bridge wall, the highest furnace temperature is said to be maintained and the temperature of the fuel gases not reduced until the combustion is complete. The tubes being vertical, dust and ashes cannot, of course, collect. The gases of combustion travel over a heating surface of about 70 ft. and finally over the feed-water section before escaping. The superheater is of simple form, being composed merely of an upper and a lower steel header, into which the superheating tubes expand. Being situated in the front of the boiler it is accessible for any purpose, and in case of derangement can be entirely removed while the boiler is under pressure. The simple nature of the connections permits easy flooding accompanied by a good circulation in the boiler. The boilers and superheaters are constructed in all sizes up to 1000 horse-power and for any pressure by the Milne Boiler Company, of New York City.

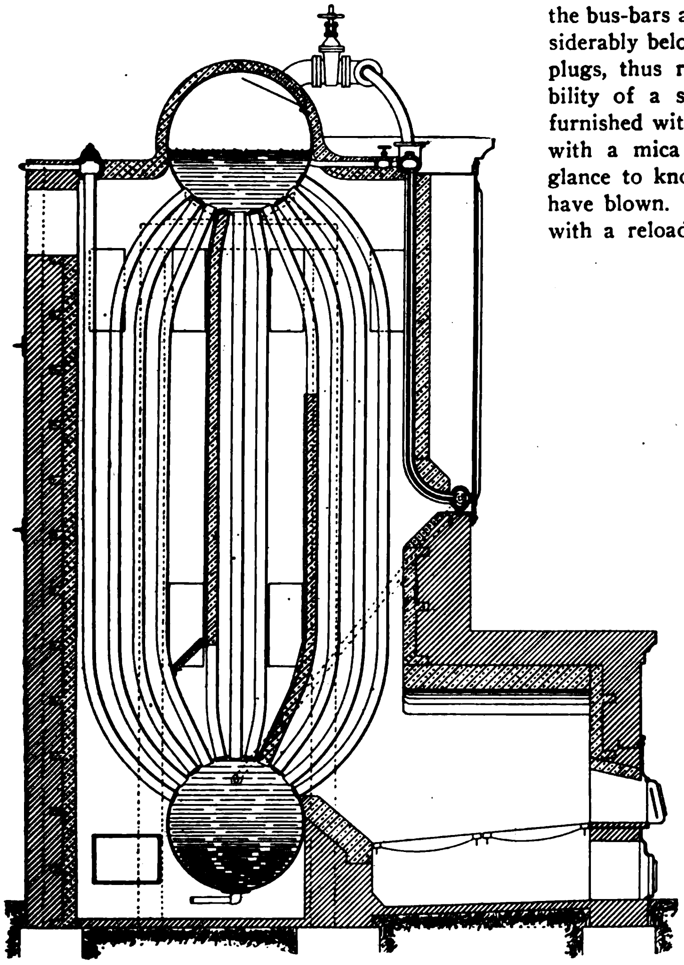


FIG. 9.—MILNE WATER-TUBE BOILER.

FUSE PLUG CABINET PANELS.

The line of cabinet panels manufactured by the General Electric Company is furnished for 125 and 250-volt service, in a variety of arrangements and circuits to meet the requirements of practically all installations. The distinctive feature of these panels is the employment of the well-known Edison fuse plugs on the different circuits. The plug type of panel seems to have an advantage over the cartridge fuse type in that the bus-bars and connections are placed considerably below the level of the tops of the plugs, thus rendering very remote the liability of a short circuit. The fuse plugs furnished with the 125-volt panels are fitted with a mica cap which enables one at a glance to know on which circuit the fuses have blown. The 250-volt panels are fitted with a reloadable type of fuse plug which is easily inserted without danger of shock. These panels are neat in appearance, compact and well finished, and due to the nature of the Edison plug no injury to the panel itself can take place when the fuses blow.

Fig. 10 shows a cabinet panel for twenty-six two-wire double branch circuits from two-wire mains with main and circuit switches, while Fig. 11 shows a somewhat smaller panel arranged for fourteen two-wire single branch circuits from three-wire mains with main and circuit switches. The spacing of the different panels is in conformity with the rules of the National Board of Fire Underwriters.

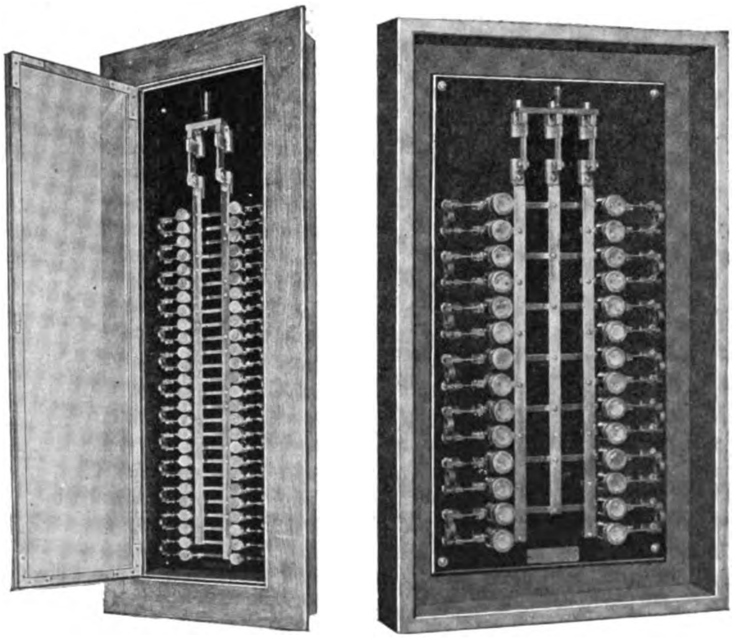


FIG. 10.—FUSE PLUG CABINET PANELS.—FIG. 11.

ALLIGATOR WRENCH FOR ELECTRICAL WORKERS.

The Applied Device Company, of Springfield, Mass., has placed on the market the alligator wrench shown by Fig. 12 herewith. This has a one and three-quarter inch offset, to allow close working to the wall or ceiling. Each wrench is provided with two jaws for right and left hand work. The wrench has a fixed and a flaring jaw, the combination of a grasping jaw and a serrated face, with a bearing jaw having a straight bearing face. In this way it both grasps and releases the pipe with ease and certainty, the curved outline of the pipe finding a tangential bearing in all parts of the opening. The curved jaw first engages the pipe, and then the straight jaw slips under or around the pipe until jammed tightly into the opening between the jaws, the action being entirely automatic. The wrench can be used with any pipe from 5-16 to 1 1-16 in. The tool is made from a forging of tool steel, the teeth being milled and hardened.

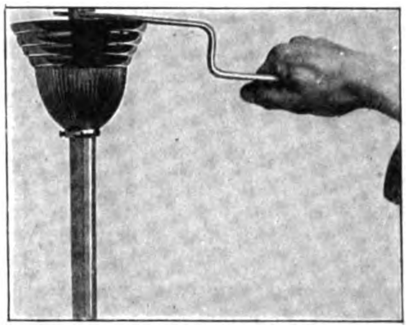


FIG. 12.—ALLIGATOR WRENCH.

BLUE PRINTING OUTFITS.

The General Electric Company has made some recent developments in their electric blue printing outfits. There are designed for the making of blue prints by means of arc lamps, and are capable of making two prints 48 in. x 36 in. or a larger number of small prints at one time. The frames are cylindrical in shape. The sides of the frames are made of curved plate glass, against which the tracings and blue prints are placed; canvas curtains operated by foot levers hold them in position. This arrangement holds the tracing firmly against the glass, insuring good contact between the tracing and blue print. The electric current is thrown on automatically by the foot lever, thus avoiding excessive waste. The frame is light, strong and durable, being constructed of angle iron and sheet steel. Its light weight renders it practically easy to move from one place to another as the occasion demands. By placing thin metal bands horizontally and vertically across the glass to hold the tracings, it is possible to make as many as thirty-two 8-in x 10½-in. prints at one time. This attachment obviates the necessity of removing the tracings until all the desired prints have been made. These outfits can be used on either direct or alternating current circuits, using in either case, the enclosed arc lamps with clear globes. Exposures are governed entirely by the condition of the tracing and the grade of blue print paper employed; the average print, however, is obtained in from one and one-half to three minutes. The General Electric Company, in its own blue printing department, during the month of January, 1904, obtained without the aid of solar light, 110,000 prints from an equipment of twelve frames.

NEW BOOKS.

Testing of Dynamos and Motors. By Charles F. Smith. Manchester, Eng.: The Scientific Publishing Company. Cloth; 240 pages, 5½ ins. x 8½ ins.; 83 illustrations. Price 5 shillings.

The reviewer takes off his hat to Mr. Smith. For completeness, conciseness, directness, accuracy, clearness of exposition and intelligent selection of methods, there is nothing in print in the English language on the testing of direct-current machinery that compares with this little book in the slightest degree. It is worth ten times its price to anyone who has to do with the class of work discussed. There may be errors, of course; there always are in first editions (and sometimes in tenth editions). None have arrested the attention of the reviewer, but no attempt has been made to verify in detail the formulas and examples given; in principle they are correct. For conveying information along the line of least mental resistance the author's style is without a superior within the range of the reviewer's observation.

The "Practical Engineer" Pocket Book. New York: D. Van Nostrand Company and The Derry-Collard Company. Leather, 577 pages, 3¼ ins. x 5¼ ins.; illustrated. Price, 75 cents.

This is the mechanical mate to the pocket book reviewed below, and is considerably superior to it in general quality. It contains many of the tables which are contained by the electrical pocket book, and many more which are equally valuable. The usual steam and mechanical engineering subjects are treated in concise style. There is also an excellent section on gas engines and one very much poorer on oil engines. Some of the gas engine data should be brought up to date: for example, tests of explosive mixtures, the data in the book being the results of Clerk's tests made in 1885 or 1886. Most of it, however, is as near up to date as it is practicable to get it. Like the electrical pocket book, this one contains extremely useful sections on shafting, belting and gearing. There is an unusually small proportion of obsolete matter in the book; in fact, this proportion is practically negligible.

Twentieth Century Hand Book for Steam Engineers and Electricians. By C. F. Swingle; Electrical section by H. C. Horstmann and V. H. Tousley. Chicago: F. J. Drake & Co. Flexible leather; 207 pages, 4½ ins. x 6½ ins.; over 200 illustrations. Price, $2.50.

This is an elementary book intended for practical steam engineers and electrical workers, and is written accordingly in plain language. It covers, as fully as could be expected for its size, boilers, furnaces and settings; boiler feed apparatus; fuel and combustion; properties of steam; evaporation, draft and calorimeter tests; engines, valves, valve setting, governor adjustment, steam indicators and their uses; feed-water heaters, condensers, etc.; electrical instruments and apparatus; circuits and wiring calculation; translating devices; care of dynamos, motors, etc.; storage batteries, lightning arresters, etc. So far as the reviewer has investigated, the subject matter appears to be accurate and intelligently prepared. Some obsolete electrical apparatus has been given probably more attention than it merits, but as some of these relics are still in practical service the information will doubtless be welcome to those afflicted with their operation and maintenance.

The "Practical Engineer" Electrical Pocket Book. New York: D. Van Nostrand Company and The Derry-Collard Company. Leather; 350 pages, 3¼ ins. x 5½ ins.; illustrated. Price, 75 cents.

This is the 1904 edition of this well-known little book, and contains a large amount of valuable data. Many parts of the book, however, appear to have remained unrevised for several years. For example, on page 117 the old Hopkinson curves of magnetic quality of iron are presented; on the next page is an example of the calculation of the magnetic circuit of a dynamo taken from the classic Hopkinson paper read in 1886; on page 122 an ancient discoidal armature and a multipolar field magnet with poles parallel to the shaft are presented as typical of the multipolar dynamo, along with elaborate calculations applying to the design. The whole treatment of the dynamo-electric machine is useless; where it is not out of date it is lamentably perfunctory. The tables of temperature coefficients, specific resistances, and other data involving ohms or volts are rendered useless because one is either not informed whether the unit is the "legal" or the B. A. or the international one, or else the data are in terms of the so-called legal units. The chapter on electrolysis is fairly good. The sections on shafts, gearing and belting are excellent, and the book contains many very useful tables. The section on dust destructors is about the most complete and modern of the entire contents, and there is a little information about elevators which may be useful. The meagre page of platitudes on gas power is unnecessary; the book would have been better off without it.

OBITUARY.

J. L. WEEKS, general manager of the American Steam Gauge & Valve Company, died in Boston on April 2 from an operation for appendicitis. Mr. Weeks was well known throughout the steam and electrical engineering circles and made hosts of friends for his company.

CHESTER D. CRANDALL, general manager of the Western Electric Company, died recently at his home in Edgewater, Chicago. Mr. Crandall was graduated from the University of Rochester in 1879, and shortly thereafter became connected with the Western Electric Company. He has been a prominent figure in Bell telephone work for many years.

THEODORE E. THEBERATH, formerly engineer for the San Francisco district office of the Stanley Electric Manufacturing Company, died at his home in San Francisco on March 29 after a brief illness. At the time of his death Mr. Theberath was connected with the California Gas & Electric Corporation; his last engineering work was the construction of the De Sabla hydraulic-electric plant.

JAMES W. HINKLEY, president of the Consolidated Electric Light & Power Company, Poughkeepsie; vice-president of the Roebling Construction Company, and a director in the Consolidated Car Heating Company, died on April 11 at his home in Poughkeepsie, from apoplexy. Mr. Hinkley was a native of New York State and descended from Puritan ancestry. He was very prominent in businiess circles; in addition to the offices just mentioned, he was president of the United States Casualty Company and director in the International Bank & Trust Company of America, the National Bank of North America and the Poughkeepsie Trust Company, and when the Walker Company was absorbed by the Westinghouse Electric & Manufacturing Company he was its president. He leaves a widow and eleven children, one of whom is Captain J. W. Hinkley, Jr., who is now stationed at Fort Washinigton.

PERSONAL.

MR. A. V. PHILLIPS has been elected president of the Electric Supply & Maintenance Company, Troy, N. Y.

MR. F. V. T. LEE has been appointed manager of the Ft. Wayne Electric Works' new branch office at San Francisco.

MR. FRANK SUTTON, consulting engineer, has removed his offices to rooms 801-804 at 91 Wall Street, New York.

MR. C. C. CRAFTS, of the Westinghouse Company's export department, recently returned from a very satisfactory trip to Mexico.

MR. F. D. PHILLIPS, who was for some time with the Electric Appliance Company, Chicago, has been elected vice-prisident of the Crescent Company, of that city.

MR. E. W. RICE, JR., chief of the engineering department of the General Electric Company, has been elected a director of the company to succeed the late W. C. Whitney.

MR. W. P. FIELD, formerly of the St. Louis office of the Crocker-Wheeler Company, will be put in charge of the company's new office in New Orleans when that office is opened on May 10.

MR. FRED SARGENT, the well-known consulting engineer of Chicago, recently returned from a trip to Europe, where he spent several weeks investigating the steam turbine and central station development in that country.

MR. C. C. STARR, formerly of the firm of John Starr, Son & Co., has been appointed representative of the Canadian Westinghouse Company, Ltd., for the maritime provinces, with headquarters at 134 Granville Street, Halifax, N. S.

MR. P. G. GOSSLER has resigned his position as general superintendent and engineer of the Montreal Light, Heat & Power Company to accept the general managership of the operating department of J. G. White & Co., of New York.

MR. W. A. CALDWELL, formerly connected with the Chicago office of the Standard Underground Cable Company and recently located at the home office of the company, has been appointed manager of the company's new St. Louis office, recently established.

MR. W. H. DOPP, who has been for some time on the staff of the Stanley Electric Manufacturing Company, Pittsfield, Mass., has severed his connection with that company to accept the position of superintendent of the Pope Manufacturing Company's branch factory at Hagerstown, Md.

MR. G. L. CROSBY has been appointed district representative of the Western Electrical Instrument Company for Western Pennsylvania, Ohio and Michigan, and has established headquarters at 426 Williamson Building, Cleveland, Ohio. Mr. Crosby will also handle the General Incandescent Arc Light Company's circuit-breakers.

MR. W. F. BAKER has been appointed contract agent for the New York Telephone Company, to succeed Mr. F. H. Bethell, who has been promoted to the managership of the Potomac Telephone Company. Mr. Baker has been with the contract department for over six years, and during the past two years has been special agent for the Dey Street division.

MR. W. F. WARDEN, president and general manager of the Burt Manufacturing Company, Akron, Ohio, sailed for Europe on April 15. Mr. Warden will visit his company's agents in England, France, Germany, Belgium, Denmark, Norway, Sweden and Russia. Mr. J. Asa Palmer, secretary of the company, will have charge of its affairs during Mr. Warden's absence.

MR. ERVIN DRYER, of the Westinghouse Electric & Manufacturing Company's sales department, has resigned his position there to accept a similar one with the Allis-Chalmers Company. Mr. Dryer is one of the best known and most popular salesmen in the electrical and mechanical field. His headquarters will be at the Chicago office of the company, and the scope of his work will include the sale of steam machinery as well as electrical apparatus.

MR. ARTHUR WARREN, the originator of the Westinghouse Companies' publishing department and the manager of that department from its inception up to February 1 of this year, has organized a similar bureau for the Allis-Chalmers and Bullock interests, with headquarters in the New York Life Building, Chicago. Although Mr. Warren's appointment was very recent, the influence of his department is already being felt throughout trade circles.

MR. E. R. CARICHOFF, who has been prominently identified with the engineering staff of the Otis Elevator Company for several years past, is now on the staff of the International Steam Pump Company and is engaged in installing a very complete lighting and power distributing plant at the new works of that company, which are in course of construction at Harrison, N. J. All of the machinery will be driven by electric power, and many of the tools will have individual motors.

MESSRS. KEMPSTER B. MILLER and S. G. McMEEN, widely known telephone engineers, have embarked in consulting engineering and patent work, with headquarters at 1442 Monadnock Block, Chicago. Mr. Miller is a graduate of Cornell University and has had several years' experience as examiner of telephone patent applications in the U. S. Patent Office, which position he gave up to join the staff of the Western Telephone Construction Company, Chicago, one of the pioneer independent telephone manufacturers. Later he was instructor in telephony for the International Corespondence Schools, from which position he went to the Kellogg Switchboard & Supply Company, where he did notable work in furthering independent telephone interests. Mr. McMeen was long chief engineer of the Central Union Telephone Company. He is a graduate of Purdue University and went to the Central Union Telephone Company immediately after graduating.

TRADE PUBLICATIONS.

ELECTRIC BLUEPRINT OUTFITS. General Electric Company.—This is bulletin No. 4374 devoted to blueprinting frames in which enclosed-arc lamps are used as the source of light.

PORTABLE CRANES. The Franklin Portable Crane & Hoist Company, Franklin, Pa.—A handsomely executed catalogue of pocket size, containing illustrations and tabular data of the well-known Franklin portable crane.

STANDARD FAN MOTORS. The Robbins & Myers Company, Springfield, Ohio.—Catalogue No. 38, illustrating and describing the line of Standard ceiling and desk fan motors built by this company and described in the March number of the AMERICAN ELECTRICIAN.

LIGHTNING ARRESTERS. Garton-Daniels Company, Keokuk, Iowa.—Catalogue No. 40 of standard size, in which the features of the well-known Garton lightning arresters are clearly explained with the aid of handsomely executed half-tone engravings.

"P-K" LIGHTING SPECIALTIES. H. T. Paiste Company, Philadelphia.—This is supplement No. 11 to the Paiste catalogue No. 10 and is devoted to "P-K" lamp sockets, plugs and receptacles, show-window receptacles, baby knife switches and rosettes.

NAME PLATES. Crowe Metal Manufacturing Company, Chicago.—A catalogue of standard size, containing *fac simile* illustrations of the various styles of name plates made by this company. The styles shown in the catalogue are all tasteful, and in many cases artistic in design.

ARC LIGHT SWITCHBOARDS. General Electric Company.—This is bulletin No. 4362, containing an illustrated description of the carrier bus arc light circuit switchboard panels manufactured for use in conjunction with Brush arc lighting dynamos. Connections are made by means of plug connectors and sockets.

HIGH-SPEED AUTOMATIC ENGINES. Ames Iron Works, Oswego, N. Y.—This is the latest catalogue of the well-known Ames automatic center-crank engine which is widely used for electric light service. The catalogue is well executed and the details of engine construction are fully illustrated and described.

PIPE TOOLS, DRILLS AND FORGES. John V. Gibbons, New York.—A well prepared catalogue of convenient size, devoted to pipe cutting and threading tools, pipe wrenches, hand drills, portable forges and steam specialties.

DIRECT-CURRENT MOTORS. Bullock Electric Manufacturing Company, Cincinnati, Ohio.—Bulletin No. 1023 superseding bulletins 1021 and 1022 and devoted to the Bullock type B motor, which is built in the bipolar type up to 7½ horse-power and in the multipolar type from 7½ to 25 horse-power.

ELECTRIC LIGHT AND RAILWAY EQUIPMENT. Railway & Electric Equipment Company, Philadelphia and Buffalo.—A vest-pocket pamphlet containing a list of generators, motors, engines, boilers, cars, rails, rotary converters and other power plant and railway equipment which the company has for sale.

DIRECT-CURRENT DYNAMOS AND MOTORS. The Holtzer-Cabot Electric Company, Boston, Mass.—Bulletin No. 300, containing a well-illustrated detailed description of the Holtzer-Cabot "Type M" direct-current dynamos and motors. These machines are built in outputs ranging from 1 horse-power to 160, with corresponding dynamo ratings.

THE S. K. C. SYSTEM. Stanley Electric Manufacturing Company, Pittsfield, Mass.—A nicely executed book entitled "A Synopsis of the S.K.C. System," and, as its title indicates, taininig illustrated descriptions of the various pieces of apparatus which are included in the system. These are too well known to require specific mention.

INTERIOR TELEPHONES. The Lambert-Schmidt Telephone Manufacturing Company, Weehawken, N. J.—Catalogue No. 11, containing profusely illustrated descriptions of the several types of interior telephone apparatus made by this company. The mechanical work on the catalogue is of almost as high a grade as that which characterizes the Schmidt apparatus.

INTERCOMMUNICATING TELEPHONE DIAGRAMS. The Holtzer-Cabot Electric Company, Boston, Mass.—Bulletin No. 149, containing diagrams for connecting up all of the various intercommunicating telephone systems manufactured by the Holtzer-Cabot Company. The bulletin also contains very useful information in addition to the diagrams and the remarks pertaining thereto.

DIRECT-CURRENT CRANE MOTORS. Westinghouse Electric & Manufacturing Company.—Circular No. 1077 containing an illustrated description of the new line of Westinghouse direct-current crane motors, which are series-wound machines known as "Type L." The controllers used in connection with these motors were described in the New Apparatus department of this paper.

CORLISS ENGINES. Murray Iron Works, Burlington, Iowa.—Catalogue No. 55, in which are illustrated and described the Murray Corliss engines. These are built in several forms of frame, including the simple and box girder frames, Tangye frame and the rolling mill type of frame. The catalogue also includes illustrations and data relating to boilers and feed-water heaters built by this company.

HAND-GEARED BLOWERS. Buffalo Forge Company, Buffalo, N. Y.—This is a pocket-size folder containing illustrations and brief descriptions of the Buffalo hand-operated blowers known as Nos. 99 and 100 and Buffalo portable forges equipped with these blowers. The fan shaft is mounted in ball bearings and is geared to the crank shaft through two sets of special gears which are completely enclosed and also mounted on ball bearings.

ELECTRO-MECHANICAL SPECIALTIES. Engberg's Electrical & Mechanical Works, St. Joseph, Mich.—A nicely executed catalogue of standard size, containing illustrated descriptions of engine and generator sets, switchboards, search lights, electro-hydraulic valves and other specialties. The generating sets are very compact, consisting of a single cylinder vertical engine, of the automatic cut-off type, of course, direct-connected to a six-pole direct-current dynamo.

DIRECT-CURRENT MOTORS. Sprague Electric Company, New York.—Bulletin No. 216, containing an illustrated description of the Sprague Company's latest line of motors which is known as the M. C. Type. These are all four-pole machines, except the smallest size, which is bipolar, and are wound for outputs ranging from 5 horse-power to 20 in slow and moderate speeds, with open frames, and correspondingly reduced outputs with semi-enclosed and entirely-enclosed frames.

THREE-PHASE TRANSFORMERS. General Electric Company.—Bulletin No. 4370, containing illustrations and a description of the G. E. three-phase air-blast transformers which are of the so-called shell type. The advantages of a three-phase transformer over three single-phase transformers are graphically presented by several of the illustrations, and the construction of the three-phase apparatus is also clearly shown. These transformers are built in sizes ranging from 150 to 1100 kilowatts.

RAILWAY MOTORS. General Electric Company.—Bulletin No. 4361, devoted to the G.E.-70 motor, which is somewhat similar to the G.E.-74 machine recently brought out. A distinctive feature of the new motor is in the construction of the field-magnet frame. The frame is an octagonal box divided horizontally, but the dividing line is not through the center of the motor as in the ordinary type of machine; it is considerably above the center line. The armature shaft bearing housings are cast with circular flanges which fit into suitable spaces in the ends of the lower part of the field-magnet frame.

ELECTRIC HEATING APPARATUS. Simplex Electric Heating Company, Cambridge, Mass.—This is catalogue No. 12 and contains 82 pages of illustrated descriptive matter relating to the large line of electric heating apparatus manufactured by the Simplex Company. The line includes chafing dishes, coffee urns, tea pots, milk warmers, ornamental griddles, sauce pans, ovens, broilers, waffle irons, and almost every other form of cooking utensil; immersion coil heaters, heating pads, curling-iron heaters, glue pot heaters, soldering irons, sterilizers, smoothing and pressing irons and other laundry utensils. Radiators and foot warmers are also included in the line, and the company supplies all of the necessary fittings, such as switches, plugs, connectors, etc.

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BUSINESS NEWS.

CURTIS STEAM TURBINES are to be installed in the station of the Nice Gas & Electric Company, Nice, France.

THE MAXFIELD-FRANCKE COMPANY has removed its main offices from 120 to 136 Liberty Street, New York.

BALL ENGINE COMPANY, Erie, Pa., reports a continuance of good business in its well-known lines of automatic and Corliss engines.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., have established a Pacific Coast office in San Francisco, at 69-75 New Montgomery Street.

ELECTRICAL EQUIPMENT AND SUPPLY COMPANY, Pittsburg, Pa., has been appointed representative of the Yost Electric Manufacturing Company for Pittsburg and vicinity.

WILLIAM S. BROWN, New York representative of the Chase-Shawmut Company, of Newburyport, Mass., has removed his offices from 39 Cortlandt Street to 3 West 29th Street.

GARTON-DANIELS COMPANY, Keokuk, Iowa, reports that its business for the first three months of the current year is considerably greater than that of any similar period in previous years.

HUGO REISINGER, New York, importer of electra carbons, has been awarded the contract by the Louisiana Purchase Exposition Company for all of the carbons required by the Exposition.

G. M. GEST, New York and Cincinnati, has been awarded the contract by the Bell Telephone Company of Cincinnati for the installation of a large conduit system in Cumminsville, a suburb of Cincinnati.

BROWN-CORLISS ENGINE COMPANY, Corliss, Wis., reports among recent sales two large tandem compound condensing Corliss engines, ordered by the Phillips Insulated Wire Company, Pawtucket, R. I.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., has established a branch office in the Security Building, St. Louis, Mo. The company now has seven district offices throughout the country.

GOULD STORAGE BATTERY COMPANY will remove its offices on May 1 from 18 West 34th Street to the New Century Building, 1 West 34th occupying the entire eighth floor of the New Century Building.

THE NERNST LAMP COMPANY has removed its Boston office from 131 State Street to 501 Atlantic Avenue. Mr. George C. Ewing will continue as district manager, and the office will carry a complete stock of Nernst lamps and supplies.

WESTERN TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., has leased commodious quarters in the Atlantic Building, 42 West Jackson Boulevard, and removed its factory and office from 73 West Jackson Boulevard to the new quarters.

HYATT ROLLER BEARING COMPANY, Harrison, N. J., has broken ground and let contracts for a 75-foot addition to its new machine shops, this addition being rendered necessary by increased business notwithstanding the new shops have been completed only six months.

THE MURRAY IRON WORKS COMPANY, Burlington, Iowa, advises us that the Murray Corliss engine at the St. Louis Exposition grounds was started up on April 10 and was the first one of the group of engines in the intramural railway power station to be put in operation.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, now has Exide battery stations in twelve cities distributed throughout the country. Each of these stations is in charge of an experienced storage battery man and stocked with a full line of automobile battery material.

SCOTT & HAUGER, Rockwood, Pa., have been awarded the contract for installing a complete electric light plant at the Markleton Sanitarium, Markleton, Pa., to replace the one recently destroyed by fire. The generating equipment will consist of Erie engines and Milwaukee generators.

ELECTRICAL TESTING LABORATORIES is now the title of the company heretofore known as The Lamp Testing Bureau. The company has moved into its new office and laboratories at 80th Street and East End Avenue, New York, and is prepared to do testing and standardization of all classes of instruments and electrical apparatus.

THE D. & W. FUSE COMPANY, Providence, R. I., has brought out a remarkable insulation for magnet wires, which is designed to supersede the ordinary cotton covering now used. The new insulation is a preparation of asbestos and is said to be indestructible and at the same time the full equal or superior in insulating properties of the standard double cotton covering.

THE F. BISSELL COMPANY, Toledo, Ohio, reports large sales of its automatic time switches. These compact devices are meeting with much favor for the control of lamps in display windows. The use of the switch enables the store proprietor to leave his lights burning when the store is closed for the day and have them extinguished at a predetermined hour later in the night.

KELLER, PIKE & CO., Philadelphia, have established a branch office in Baltimore, Md., at 211 North Calvert Street. This office will be in charge of Mr. John S. Dobler, of Baltimore, who has had a wide experience in electrical contract work. The firm has just been awarded the contract for the complete mechanical and electrical equipment of the new Camden County court house.

THE H. W. JOHNS-MANVILLE Company is constantly in receipt of highly commendatory letters relating to its Kearsarge gaskets. A recent letter from Missouri states that Kearsarge and rubber gaskets were applied simultaneously to two different engines, an equal number of each to each engine, and that up to date the Kearsarge gaskets have each outlasted fifteen other gaskets.

THE BRISTOL COMPANY, Waterbury, Conn., is sending its World's Fair exhibit to St. Louis. The company's booth will be located in space No. 36, near the main entrance of Electricity Building, and will contain a complete line of the well-known Bristol recording instruments in various styles and sizes. There will also be exhibited a full line of Bristol steel belt lacing.

NEW JERSEY ASBESTOS COMPANY, Camden, N. J., reports that its "Gladiator" asbestos-metallic goods have met with much success. The company makes a complete line of asbestos-metallic packings, gaskets, etc., composed of asbestos sheeting with fine brass wire spun into the center of the threads of both warp and woof, the fabric being rendered water-proof by a coating of India rubber solution.

GOLD CAR HEATING & LIGHTING COMPANY, New York, has taken a large suite of offices in the Whitehall Building, 17 Battery Place, New York, and has transferred both its New York and Chicago offices to these headquarters. The company announces that it has made an arrangement whereby it has the exclusive sale in the United States of the new Edison storage battery for car lighting purposes.

THE REEVES ENGINE COMPANY, Trenton, N. J., reports among recent sales the following: A 400-h.p. vertical cross-compound engine to the Drew-Selby Company, Portsmouth, Ohio, and a similar engine to Platner & Stoddard, Dayton, Ohio; a large vertical cross-compound engine for the Trenton Mills and Elevator Company, and three simple horizontal engines to the Construction Railroad Company, New York. All of these are for driving electric generators.

B. F. STURTEVANT COMPANY, Boston, Mass., has made generous recognition of its publication department in the allotment of space in its new building at Hyde Park. A portion of the basement about forty feet square will be devoted to a press room and a storage space for paper stock and printed matter, and a complete equipment of type and printing presses will be installed. Immediately above the printing room will be offices for the artists, clerks and others in this department.

THE STANDARD VITRIFIED CONDUIT COMPANY, New York, since completing its large plant at South River, N. J., is in splendid position to take care of its rapidly growing business. The company's manufacturing plant has been crowded continuously since it began operations in 1902, and the new plant with its fine equipment of machinery and greater facilities in every way will relieve the pressure considerably. The company is manufacturing single and multiple-duct conduit, and the factories now have a capacity of about 40,000,000 feet per annum.

CROCKER-WHEELER COMPANY, Ampere, N. J., will open a branch office in the Hibernia Bank Building, New Orleans, on May 10. Although the company has fifteen branch offices throughout the country, including one at St. Louis and one in Atlanta, the New Orleans office has been found absolutely necessary in order to take care of the steadily increasing business in the South and Southwest. The company recently increased its capital stock from $1,000,000 to $2,000,000 and is now one of the largest electrical manufacturers below the financial plane of the General Electric and Westinghouse companies.

NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., has inaugurated a new department which will undoubtedly be a blessing to those connected with the company. This comprises two pleasant dining rooms, a butler's pantry and a kitchen, the object being to supply dinner to those engaged in the executive and engineering departments of the company at the company's expense. While there will be no charge to the employees for the dinners, the company frankly confesses that its motives are not entirely philanthropic; it is believed that this arrangement will result in closer touch, and consequently more efficient co-operation, between the various members of the executive and engineering staffs.

THE FOOS GAS ENGINE COMPANY, Springfield, Ohio, recently gave an interesting demonstration of its "special electric" gas engine at its works. A number of representatives from well-known electrical manufacturing companies were present at the tests. The engine was built for the Foos exhibit at the St. Louis Exposition and is of the four-cycle type with throttling speed regulation. On the occasion mentioned, the visitors were shown some twenty gas engines for ordinary service on the testing floor and a hundred or more ready for shipment. Among the electrical manufacturers represented at the tests were the Fort Wayne Electrical Works, the Crocker-Wheeler Company, the Thresher Electric Company, the Akron Electric and Manufacturing Company and the Jenney Electric Manufacturing Company.

CENTRAL STATION NEWS

ALABAMA.

JACKSON.—Mr. B. H. Warren is said to be interested in the establishment of an electric light plant here.

MARION.—The Marion Light & Power Company recently added a duplicate alternator to its equipment.

HUNTSVILLE.—Mr. A. B. Coryell is now superintendent of the Huntsville Railway, Light & Power Company.

CULLMAN.—Mr. A. Dreher, Jr., has been made purchasing agent of the municipal electric light plant of Cullman.

DEMOPOLIS.—It is the intention of the Demopolis Electric Light & Power Company to extend its plant by the addition of a brick engine room 37 ft. x 75 ft.

SELMA.—The Selma Lighting Company is contemplating enlarging its plant and for this purpose will install a new boiler, engine, steam pipe line and accessories.

TALLADEGA.—The Talladega Light & Power Company has let the contract for the construction of a dam at Choccolocco Creek, about eight miles from here. The dam, it is said, will cost $25,000 and will increase the capacity of the present plant considerably.

ALASKA.

DAWSON CITY.—The Dawson Electric Light & Power Company, Ltd., is considering the installation of underfeed stokers.

STEWARD.—Articles of incorporation have been filed by Mr. George E. Dickinson and George Sohus for the Steward Electric Company.

ARKANSAS.

PINE BLUFF.—The Pine Bluff Light & Water Company intends to install a new engine direct connected to an alternating-current generator.

HARRISON.—The Harrison Electric Lighting & Ice Company has added a day circuit to its service; the current is supplied upon a meter basis exclusively.

MALVERN.—Mr. Joseph Brown is now superintendent and chief engineer of the Malvern Light & Power Company. It is understood that the company contemplates installing a new dynamo and boiler.

MONTICELLO.—The present officers of the water and light plant are reported as follows: Mr. Patrick Henry, president; Mr. George A. Knox, secretary; Mr. J. J. McClay, treasurer; Mr. D. A. Tramwell, chief engineer, and Mr. W. J. Kinney, chief electrician.

CALIFORNIA.

LOS GATOS.—Mr. J. D. Farwell is now manager and superintendent of the Los Gatos Light & Power Company.

LODI.—Cary Bros. have completed arrangements for connecting their plant with the American River power line.

MARTINEZ.—The Contra Costa Electric Light Company is considering the construction of a seven-mile line to Concord.

FERNDALE.—It is understood that the Ferndale Electric Light Company contemplates installing an entire new outfit.

SAN FRANCISCO.—Mr. J. F. Lawless has succeeded Mr. A. Pollock as manager of the San Francisco Gas & Electric Company.

BERKELEY.—The contract for lighting the city for two years beginning April 1 has been secured by the Berkeley Electric Company.

SANTA PAULA.—The city contract of the Santa Paula Electric Company provides for forty 16-c.p. incandescent lamps on a moonlight schedule.

FULLERTON.—The City Attorney has been advised to prepare advertisements offering for sale a franchise privilege for electricity for light and power purposes.

EL PASO.—It is reported that an electric power plant will soon be established here by the Southern Pacfic Company for operating the machinery in its railroad shops.

SANTA CLARA.—The city electric light plant is now being supplied with high-tension current by the Standard Electric Company over a long-distance transmission line.

VISALIA.—The Mt. Whitney Power Company, of this place, is erecting a second power plant, the equipment to consist of three 500-kw. units driven by a Stillwell-Bierce & Smith-Vaile turbine.

SAN FRANCISCO.—Articles of incorporation have been filed by the Century Electric Corporation, composed of F. L. Greenwood, C. M. Wood, and others. The new company is capitalized at $250,000.

LOS ANGELES.—The Edison Electric Company of Los Angeles is installing a gas plant at San Pedro. Contracts for the apparatus have been closed. The company is now doing business in ten or a dozen cities and towns in Southern California.

SAN FRANCISCO.—Mr. Theodore E. Theberath, electrical engineer, died at his home in this city on March 29, after a brief illness. He was sent to the coast as engineer for the San Francisco district agency of the Stanley Electric Manufacturing Company and of late years has been in the employ of the California Gas & Electric Corporation. He was 40 years of age at the time of his death.

SAN FRANCISCO.—It is stated by an official of the California Gas & Electric Corporation that while the water supply and electric power plants owned by the South Yuba Water Company and the Central California Electric Company have not yet been taken over, the option held will probably be exercised very shortly. This deal and the taking over of the Standard Electric Company were arranged for at the same time and the financing of the one depended upon the other.

YREKA.—It is reported that the Little Shasta Power Company, which was recently incorporated, is to be a sub-company of the Siskiyou Electric Power Company, who have signed contracts to deliver at Montague all of the power required by the former company. The Terwilliger power line has been purchased by the Little Shasta Company, who will supply current for light and power throughout the Little Shasta Valley. Among those promoting the enterprise are Mr. W. H. Roberts, Mr. M. T. Jones and Mr. J. F. Reisser.

SAN FRANCISCO.—The new equipment to be installed by the San Francisco Gas & Electric Company in their plant at Station "A" includes one General Electric 11,000-volt, rotating-field, engine-type generator, a Union Iron Works vertical engine and five Babcock & Wilcox boilers. The generator will be direct-connected to the triple expansion engine. Two of the engines from Station "B" will be moved to Station "A," formerly owned by the Independent Electric Light & Power Company. This will have a capacity of 15,000 kilowatts or more and is to be made the principal generating station for the city. The changes will enable the company to dispense with steam engines at the old stations. Charles C. Moore & Co. secured the contract for the new boilers and the moving of six Heine boilers from another station, together with the remodeling of the boiler plant. The boilers will all be equipped with B. & W. marine oil furnaces and the Charles C. Moore & Co. oil fuel system will be installed. The five new B. & W. boilers will have forged-steel drums and superheaters, and two special Goubert oil heaters will be used. The auxiliaries will also be supplied through Charles C. Moore. Instead of extending the electric motor system for condensing apparatus, etc., steam-driven pumps will be used throughout. The plant will be equipped with two compound duplex Snow feed pumps, each having a capacity to feed a 16,000-h.p. boiler plant.

COLORADO.

MONTROSE.—The Montrose Electric Light & Power Company expects to double the present capacity of its plant.

ROCKWOOD.—Work is being pushed on the large power plant of the Rockwood Power Company. It is expected that this plant will supply electricity for power and light to enterprises and towns in five counties. The reservoir, it is said, will be the largest in the state.

VICTOR.—It is reported that plans are under way for the erection of an electric plant to be owned by individuals of the city on a co-operative plan. Mr. C. L. Varney is chairman of the Ways and Means Committee appointed by the citizens at a mass meeting held recently.

LAKE CITY.—The present officers of the Hinsdale Electric Light & Power Company are reported as follows: President and manager, W. F. Green, of Lake City; secretary, C. H. Meyer, Gunnison; treasurer, Miss Ida V. Meyer, Gunnison; chief engineer, A. C. Johnson, Lake City.

DURANGO.—The Durango Light & Power Company is contemplating a change from 55-volt secondary distribution to 110-220 volts, three-wire system; each block in the business section to be supplied through one transformer, and every two blocks to be supplied through one transformer in the residence section.

CONNECTICUT.

WALLINGFORD.—The Borough Electric Works are adding a new 225-kw. machine to their equipment.

WOODBURY.—It is said that the reservoir and electric light plant which it is proposed to construct here will cost $15,000.

PUTNAM.—The Putnam Light & Power Company expects to erect a new station at Mechanicsville and will extend its lighting and power service to that town.

HARTFORD.—The report of the special committee appointed to consider the matter of street lighting recommended the rejection of all bids received and, after further investigation, advertising for new bids.

GLASTONBURY.—The Glastonbury Power Company has been incorporated, under the laws of Connecticut, with an authorized capital stock of $350,000, the object of the company being to develop the water power of Roaring Brook for electric purposes. The project calls for the immediate development of 1600 horse-power. A steel and concrete power station will be erected and two reservoirs built. The incorporators are Lewis W. Ripley, Henry S. Goslee, D. Willard Williams, James S. Williams, J. H. Hale and Frank D. Glazier.

DELAWARE.

DOVER.—At a recent meeting of the Town Council, the Water and Light Committee recommended that $8,500 be expended for improvements to the water and light plant.

DISTRICT OF COLUMBIA.

WASHINGTON.—A bill has passed the Senate and is now in the hands of the District of Columbia Committee in the House, providing for the regulation of electric wiring in the District of Columbia.

FLORIDA.

JACKSONVILLE.—A 500-kw. generator will soon be added to the equipment of the electric light plant here.

BARTOW.—New dynamos and engines are about to be installed in the city electric light plant.

TAMPA.—The suit for $25,000, recently instituted by Mrs. Lila Hunnicut against the Tampa Electric Company for the death of her husband, has been thrown out of court.

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GEORGIA.

AUGUSTA.—Mr. James W. Jackson is now president of the Augusta Railway and Electric Company, and Mr. C. G. Goodrich is vice-president.

GAINESVILLE.—The city water and light plant is to be furnished with a complete new equipment for 75 or 100 alternating-current enclosed arc lamps.

ELBERTON.—The City of Elberton is preparing to install a new dynamo and water-wheel governor, and it is thought that a higher dam will be built.

GREENSBORO.—A franchise for the construction and operation of an electric light plant has been granted to R. L. West, of Atlanta, and T. B. Rice, of this place.

SAVANNAH.—The Savannah Electric Company is considering the matter of extending its lines to Tybee, Ga., for the purpose of furnishing lighting current to that town.

COLUMBUS.—Upon the recommendation of the Lighting Committee, the proposition of the Columbus Railroad Company to furnish street lighting for 1905, 1906 and 1907 has been accepted.

IDAHO.

GRANGEVILLE. — The Grangeville Electric Light and Power Company will build a line to Denver, Cottonwood and Dewey.

BURKE.—The Canyon Creek Electric Company has placed an order for a 100-h.p. motor to take the place of the engine now in use.

COEUR D'ALENE.—The Consumers Company, of this place, has received the machinery for the addition which it is making to its electric plant.

NEZPERCE.—The Nezperce Electric Light and Power Company is considering the erection of a line to Greer and also one to Mohler, both in this State.

MOSCOW.—It is expected that the Moscow Electric Light and Power Company will soon establish transmission lines to Pullman and Genessee, and will use water power from Asotin.

LEWINSON.—Attorney J. H. Smith, representing Judson Sanford, is asking the City Council for a 25-year franchise for the construction of an electric line over the streets and alleys of the city.

POCATELLO.—The American Falls Power, Light and Water Company is arranging for the construction of a new generating station and substation, which will be duplicates of those already in operation.

MOSCOW.—Mr. Francis Jenkins, of this city, is reported to have purchased the right to utilize the Elk Creek Falls, about fifty miles above Lewiston, and will build a large plant for the generation and transmission of power.

NEZ PERCE.—Judge Stearns and Mr. E. A. Eitsen, who have been obtaining the rights of way along the proposed electric road between this point and Lewiston, report that with the exception of three places all have been secured for the entire distance. The three places that have withheld right of way are delaying on account of rights sold to the Northern Pacific Company five years ago.

ILLINOIS.

PARIS.—New boilers have been added to the equipment of the municipal electric light plant.

OTTAWA.—It is estimated that the proposed electric light plant for Ottawa will cost $8,000.

MT. OLIVE.—Several improvements to the municipal electric light plant are contemplated.

WASHINGTON.—The Eagle Electric Works have substituted enclosed arc lamps for open arc lamps.

LOCKPORT.—It is proposed to enlarge and improve the municipal electric light plant in the near future.

SULLIVAN.—An addition of five arc lamps has been made to the lighting circuit of the City Light and Water Works.

CHARLESTON.—Mr. E. C. Jenks is now manager and superintendent of the Charleston Gas and Electric Company.

LINCOLN.—The Lincoln Water and Light Company recently installed a new power line.

HILLSBORO.—The Hillsboro Electric Light and Power Company is engaged in building a 12-mile transmission line.

BATAVIA.—Mr. A. R. Augustine is now superintendent of the municipal electric light and water plant of this place.

GREENUP.—The Municipal Electric Light Plant is said to be contemplating changing from direct to alternating current.

CORNELL.—The Cornell Electric Light Company is preparing to enlarge its electric plant and install a steam heating plant.

QUINCY.—The Council has under consideration the granting of a franchise to the Independent Gas and Light Company.

EFFINGHAM.—Bids will be received May 17 for lighting the streets and alleys here with about sixty arc lights of 2000 candle-power each.

WHEATON.—It is expected that the equipment of the municipal plant will be increased by the addition of a 150-h.p. engine and boiler.

O'FALLON.—The O'Fallon Electric Light, Power, Heat and Water Company is putting all its arc lights on alternating-current circuits.

NUNDA.—The Union Light and 'Phone Company expects to increase its equipment by the addition of a new engine, boiler and dynamo.

ATHENS.—The Burnett-MacMaster Electric Light Company is planning to increase the capacity of its plant by adding another 100-h.p. boiler.

GREENVILLE.—The Greenville Electric Light, Heat and Power Company recently installed 38 140-cycle constant-potential arc lamps for street lighting purposes.

CHICAGO.—The Commonwealth Electric Company proposes to extend its plant and for this purpose has purchased property on Chicago River adjacent to its works.

RIDGEFARM.—It is reported that a company was recently organized by C. O. Linn and William Henderson for the purpose of erecting an electric light plant here.

CHICAGO.—It was recently voted by the stockholders of the Lake Street Elevated Railroad to change the name to the Chicago & Oak Park Elevated Railroad Company.

HENNING.—Mr. Robert Wilson, of this place, recently bought the plant of the Potomac Electric Light Company and it is stated that he will at once extend the line to Henning.

WOODSTOCK.—The municipal plant recently adopted alternating-current series arc lamps and the erection of additional alternating-current lines for street lighting purposes is contemplated.

ASHLEY.—The municipal electric light plant, which began operation last year, is making a good showing. Mr. G. Johnson is manager and chief electrician and Mr. Z. Johnson is chief engineer.

ALPHA.—The Alpha Electric Light and Power Company is considering extending its service to an adjoining town, for which purpose it will be necessary to erect from five to eight miles of new lines.

MATTOON.—The Mattoon Heat, Light and Power Company considers the flat rate system unfair to its meter customers and announces that after June 1 the meter system will be used exclusively.

MT. MORRIS.—The Mt. Morris Electric Light and Power Company is now operating a direct-current day circuit and expects to install a new boiler and a direct-connected unit during the coming summer.

STERLING.—The Sterling Gas and Electric Light Company is replacing the old poles in the down-town district with new ones of uniform size. When this work is completed the apparance of the business section will be greatly improved.

QUINCY.—The Quincy Gas and Electric Company has made improvements in the equipment of its power plant involving an expenditure of $25,000. The improvements will include a 2000 horse-power engine and boiler and a new dynamo.

MARSEILLES.—Mr. W. D. Boyce, head of the water power industry here, announces that arrangements have been about completed to rebuild the dam which was recently destroyed by high water. It is estimated that the work will cost between $150,000 and $200,000.

HIGHWOOD.—Contracts for the new power station to be erected by the Chicago and Milwaukee Electric Railway have been let. The building, which will be of brick and steel construction, will cost about $150,000. The plant will have a capacity of about 1500 kilowatts.

PINCKNEYVILLE.—Bids are wanted May 2 for the construction of an electric light plant, and for power and attendance in operating the city water works pumping station. The operating company will be granted a franchise for a term of fifteen years. Thirty-five arc lights are required for the city lighting.

CARMI.—The municipal electric light plant is to be considerably enlarged. It is said that a new set of machinery will be installed which will be the duplicate of the present equipment, and that new motors and pumps are to be added. A day circuit has been added to the service and electric power will be furnished to drive the flour mills.

CHICAGO.—In his annual message to the Council, Mayor Harrison urges the passage of a law by the next Legislature providing for municipal ownership of the gas and electric light plants. He also proposes that the sanitary district water power be turned over to the citizens and that a portion of the $5,000,000 bonds be used to extend the electric lighting plant, lower the tunnels, etc.

CHICAGO.—The Commonwealth Electric Company recently acquired from the Joseph W. Drexel estate, in consideration of $65,000, 195,000 square feet of land on the south side of the Chicago river adjacent to its works, which will be used for extensions. Other real estate in that locality to the value of $565,200 has been purchased by the company, which has already expended in buildings and power plant from $2,000,000 to $2,500,000. It is estimated that within the next six or seven years it will expend at that place altogether $8,000,000.

INDIANA.

PLYMOUTH.—Mr. Fred Eich is now manager of the Plymouth Electric Light Company.

NOBLESVILLE.—Bids for a ten-year contract to light the city are being advertised for.

FLORA.—The Council has decided to construct water works and an electric light plant to cost about $20,000.

MARTINSVILLE.—The Martinsville Light, Heat, Power and Water Company expects to add to its boiler plant soon.

FT. WAYNE.—The Ft. Wayne Electric Light and Power Company will begin at once the reconstruction of its plant.

ATTICA.—The City of Attica is contemplating a general extension of its incandescent light system for residence lighting.

BICKNELL.—J. H. Barr & Co. are reported to have secured a franchise to erect an electric light and power plant in Bicknell.

RICHMOND.—It is reported that 187 street arc lamps are to be installed by the municipal electric light and power plant.

JASPER.—The electric light plant of this place has been purchased by the Town Board and will hereafter be operated by the city.

NEW HARMONY.—Bids will be received May 16 for furnishing material and construcing an electric light plant at this place.

CLAY CITY.—It is reported that a new engine is to be installed in the electric light and power plant some time during the year.

MICHIGAN CITY.—The Michigan City Electric Company is said to have obtained considerable new business, which will necessitate an extension of its lines.

MISHAWAKA.—The municipal lighting and power plant is considering the advisability of installing enclosed arc lamps to replace the open arcs in use at present.

MOORESVILLE. — The Mooresville Electric Light Company has been bought out by the Public Service Corporation, and Mr. B. V. Hubbard is now manager of the plant.

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NEW HAVEN.—All bids opened on April 5 for the construction of an electric light plant have been rejected, and new bids will probably be called for again in May.

ELKHART.—It is reported that Mr. C. G. Conn has purchased the interests of the Elkhart Power Company and has applied for a franchise to install a new electric plant here involving an expenditure of $1,000,000.

ROANOKE.—The Town Council has made arrangements with the Ft. Wayne and Southwestern Traction Company for lighting the streets and business houses with electricity. The sub-station of the company will be moved to Roanoke.

FRANKLIN.—Mr. Taylor O. Ballard has resigned the superintendency of the Franklin Light and Power Company and has been succeeded by Mr. P. F. Morgan. It is Mr. Morgan's intention to make a number of improvements in the plant.

BOONVILLE.—The City Light and Power Company has been incorporated with a capital stock of $12,000. The incorporators are: John F. Hepp, S. W. Hart, J. F. Katterjohn, John E. Madden, Dorsey Reed, Louis J. Meyer and William Roth.

VINCENNES.—The Vincennes Light & Power Company was recently incorporated with a capital stock of $200,000. It is understool that the Edward M. Deane Company, of this city, is the parent concern which has taken over the light and power company.

BLUFFTON.—It is reported that the city electric light and power plant, which was installed at a cost of $35,000, has been accepted by the council from Contractor R. S. Ashe, of Richmond. The plant provides a street lighting system and an incandescent system and furnishes power for motors.

NEWBURG.—The equipment of the Newburg Electric Light and Power Plant will be increased during the coming summer by the installation of a new generator, engine and boiler, and it is expected that a complete system of water works will be put in some time this year.

ELKHART.—It is reported that negotiations have been recently closed between the St. Joseph & Elkhart Power Company and the South Bend Electric Company, whereby the latter company acquires the surplus power of the former. As the Buchanan hydraulic development is now furnishing power to the South Bend Electric Company under similar arrangements, all of the important electric power plants of the St. Joseph River Valley will be operated in harmony.

INDIAN TERRITORY.

ATOKA.—The new electric light and power plant, recently completed at this point, is now in operation and the town is well lighted.

ARDMORE.—The Ardmore Ice, Light and Power Company has been incorporated with a capital of $125,000. A. Ruemmeli, of St. Louis, Mo., and Henry Brann and L. P. Anderson, of Ardmore, are among the incorporators.

IOWA.

MASON CITY.—The recent election held in this city resulted in a vote to install an electric light plant.

CRESTON.—General repairs and extension of its pole lines are being considered by the Creston Gas and Electric Company.

CHARITON.—It is stated that the management of the city electric light plant is planning to reconstruct its lines this summer.

ALTA.—The entire municipal plant here is to be enlarged and improved in order to enable it to give more satisfactory service.

ACKLEY.—The Ackley Electric Light, Power and Heating Company is considering the addition of a 100-h.p. boiler to its equipment.

ROCK RAPIDS.—The city is enlarging its electric light plant and may possibly adopt alternating current in place of direct current.

LE MARS CITY.—The Le Mars City Water and Light Company has changed over to direct current enclosed arcs and raised the voltage of the system.

DENISON.—The Denison Electric Light and Power Company proposes to make additions to its plant so as to increase the capacity of the plant throughout.

DES MOINES.—Mr. J. R. Lovejoy is now president of the Des Moines Edison Light Company, which is reported to have a paid-in capital stock of $1,250,000.

SANBORN.—The Sanborn Electric Light Company is reported to be owned now by Mr. J. H. Boyd, president, and Mr. M. A. Gorman, general manager of the company.

PERRY.—The contract of the Perry Electric Light, Power and Heat Company with the city covers 8 arc lights of 1400 candle-power and 140 incandescent lamps of 25 candle-power, on moonlight schedule.

FT. DES MOINES.—Contracts have been awarded for the installation of an electric light system for Fort Des Moines. Current will be supplied by the Des Moines Edison Light Company, of Des Moines, Ia.

FORT DODGE.—Mr. John Eddy has just been made superintendent of the gas works of the Fort Dodge Electric Light & Power Company. He began work with the company some time ago as section foreman and has advanced steadily to his present position.

SIOUX CITY.—Mr. L. L. Kellogg, general manager for the Sioux City Gas & Electric Company, visited Philadelphia recently to attend the annual meeting of the United Gas Improvement Company. The projected improvements in the Sioux City plant will be made in accordance with Mr. Kellogg's recommendations.

NEVADA.—It is said that the Nevada Electric Light Company has completed arrangements for the erection of an addition to its power plant. A 150-hp Corliss engine will be installed as soon as practicable, and it is understood that other machinery has been ordered which will greatly A 150-h.p. Corliss engine will be installed as soon

KANSAS.

SALINA.—The People's Light, Heat and Power Company contemplates a complete reconstruction of its plant, of which Mr. G. H. Smedley is superintendent.

ELSWORTH.—The Ellsworth Electric Light Company has added a new generator to its electrical equipment and is considering the installation of a new steam plant.

GREAT BEND.—The Grimes Light, 'Phone and Power Company expects to install a new alternator between now and fall. Mr. C. E. Stromquest is now manager of the company.

WINFIELD.—A bond issue of $30,000 for electric light was recently voted for by the citizens, besides $89,000 for water works and $15,000 to be used in prospecting for gas.

McPHERSON.—The McPherson Water and Electric Works recently completed the installation of new machinery and boilers and the efficiency of the plant has been considerably increased thereby.

BURLINGAME.—It has been decided to enlarge and improve the electric light plant here and additional bonds to the amount of $6,000 have been voted for this purpose and to pay a small outstanding indebtedness.

JUNCTION CITY.—The Junction City Electric Railway Company, which now operates a railway line between this city and Fort Riley and also supplies the lighting service for the city, is preparing to extend its lighting service to Fort Riley. It is reported that the quarters and barracks at the Post will have about 5000 incandescent lights and 43 arc lights will be required for the streets. The improvements consist of an addition to the plant and the installation of new machinery costing about $100,000. Under its contract with the government, the company is to deliver the current to a certain point on the reservation and the government will control the distribution beyond that point.

TOPEKA.—A charter has been granted to the Kansas City & Topeka Railway Company, of this city, with a capital stock of $2,500,000. The board of directors is reported as follows: John R. Mulvane, J. C. Devlin and Charles S. Gleed, of Topeka; James A. Van Osdol, of Anderson, Ind.; and Henry L. Turner, E. B. Overshiner, A. B. Nettleton, G. A. Wulkup and Arthur Overshiner, of Chicago. Mr. Van Osdol, who is also president of the company, is general attorney for the Indiana Union Traction Company. It is the purpose of the company to build and equip a standard interurban railway between Topeka and Kansas City by way of Lawrence and Olathe. The new road will enter Kansas City over the rails of the Kansas City & Olathe Electric Railway, now nearing completion, and will traverse the counties of Wyandotte, Johnson, Douglass and Shawnee, coming in from Rosedale to the center of the city over the tracks of the Metropolitan Street Railway. Entrance to Topeka has been arranged for over the tracks of the Topeka Railway system.

KENTUCKY.

OWENSBORO.—A 60-kw. unit will probably be installed soon in the Municipal Electric Works here.

PRINCETON.—The Princeton Electric Light and Power Company is expecting to put in a new engine soon to replace the one now in use.

LOUISVILLE.—An ordinance requiring the placing of all wires underground in the business section of the city is being considered by the City Council.

MADISONVILLE.—The Bailey Light and Water Company reports that it is at present supplying the city with fifty lights, a number of lamps having been added recently.

CARLISLE.—The Citizens' Electric Light and Power Company has added 200 lamps to its service and is operating them on an alternating-current system of 1,100 volts.

PRINCETON.—Mr. J. T. Eddins, Mr. Charles Pepper and Mr. E. M. Johnson, all of this city, recently filed articles of incorporation for The Princeton Electric Light and Power Company, with a capital of $20,000.

FRANKFORT.—Decision has been rendered against the city in its suit to compel the Capital Gas and Electric Light Company to pay taxes on its franchise. The court held that they need not do so under the existing contract.

WICKLIFFE.—Bids are wanted by May 2 to furnish one 60-kw. 60-cycle single-phase engine-type alternator to be connected to an engine of sufficient horse-power; also an alternating arc-light system of 25 lamps capacity complete with regulating transformers, 17 arc lamps of 6.6 amperes capacity, etc.

LOUISIANA.

BASTROP.—The Corporation of Bastrop is planning to increase all of the equipment in its electric light and power plant.

ALGIERS.—The Algiers Water Works and Electric Company is arranging for the construction of an electric railway line and contemplates installing alternating-current machines in the power house.

OPELOUSAS.—Owing to the increased demand for electric light and power service, it is expected that the City Electric Light and Water Works will have to double the capacity of the plant before long.

MAINE.

PORTLAND.—It is thought probable that in the near future the electric wires on Congress Street, this city, will be placed underground. The committee on electrical appliances has received instructions to investigate and report upon the matter.

PORTLAND.—Mr. George F. Gould has been elected president of the Solomon River Ditch Company which was recently organized here. The company has a capital stock of $1,000,000, of which nothing has been paid in, and will conduct a general electric power, light and heat business.

MARYLAND.

BALTIMORE.—The City Council has granted a franchise to the Maryland Telephone and Telegraph Company, giving that company the right to extend its business into the electric light and power field.

KENSINGTON.—The proposition to issue bonds to the amount of $50,000 for the purpose of installing a water and lighting plant was op-

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posed so strongly by the taxpayers that the mayor and council at a recent meeting decided to defer the matter indefinitely.

MASSACHUSETTS.

WESTON.—The Weston Electric Light Company recently increased its boiler plant.

MILFORD.—The office of the Milford Electric Light and Power Company is now at 131 State Street, Boston.

FALL RIVER.—The Fall River Electric Lighting Company recently declared a quarterly dividend of 1½ per cent.

STROUGHTON.—The Stroughton Gas and Electric Company has found it necessary to increase the capacity of its plant considerably.

AMESBURY.—The Amesbury Electric Light, Heat and Power Company, proposes to install an entire new equipment of electrical apparatus.

LYNN.—Mr. J. G. Lurvey has been transferred from the works of the General Electric Company here to the Publication Bureau of the same company at Schenectady.

WESTFIELD.—An appropriation of $10,500 was made at the annual town meeting for the installation and operation of a municipal power plant.

CLINTON.—The city contract of the Clinton Gas Light Company now includes, besides the arc lamps originally provided for, 205 incandescent lamps, to burn all night.

GREENFIELD.—The Greenfield Electric Light & Power Company recently put in a new boiler and a 750-h.p. engine. When the installations contemplated by the company are complete, the plant will have a capacity of 1100 horse-power.

NATICK.—In consideration of $14,000, the title to the plant formerly owned by the Natick Electric Lighting Company was transferred from the Edison Electric Illuminating Company, of Boston, to Messrs. Philip Dooskin and Nathan Finestone, both of Boston, comprising the Boston Bedding Supply Company. The deal included all the machinery, shafting, water supply, etc., formerly the property of the Natick Electric Company, but the deed specifies that the machines and appliances shall not be used by the new owners for the manufacture and distribution of electricity.

MICHIGAN.

ST. CLAIR.—The Municipal Electric Light Plant will add to its boiler plant.

LANSING.—A new arc dynamo may possibly be installed in the City Electric Light and Water Works next fall.

VICKSBURG.—Mr. George Butcher is now superintendent of the municipal electric lighting plant of this city.

ATHENS.—The Athens Electric Power and Lighting Company expects to put in a new completely equipped switchboard.

BAY CITY.—The citizens voted April 4 to issue $50,000 bonds to enlarge the capacity of the city lighting station for commercial lighting.

HART.—The Hart Electric Light and Water Works Company is contemplating installing a complete new equipment at its power plant.

HASTINGS.—This city was recently in darkness for two nights on account of the destruction of the dam of the Thornapple Electric Company by floods.

NORTHVILLE.—The Village of Northville is considering the addition of a generator and engine to the equipment of its electric light and power plant.

GRAND RAPIDS.—Floods recently disabled the electric lighting plant here by putting out the fires in the power house, leaving the city in darkness for a couple of nights.

CHEBOYGAN.—The Cheboygan Electric Light and Power Company has in course of construction an entire new water power plant capable of developing 1500 horse-power.

IONIA.—The Ionia Electric Light Company recently sustained a loss of about $15,000, due to the washing away of its plants and buildings at Wagar's Dam, four miles east of here.

ANN ARBOR.—Recent reports are to the effect that the Michigan Milling Company and Mr. Frank Cornwall are contemplating the construction of an electric light and power plant to cost about $150,000.

THREE RIVERS.—Mr. E. B. Linsley, secretary and treasurer of the Three Rivers Light and Power Company, states that the company's outstanding bonds have been reduced to $4000 as against the former amount of $11,000.

NEGAUNEE.—Extensive improvements are reported to be under consideration by the Negaunee & Ishpeming Street Railway & Electric Company. Plans are now being prepared for the enlargement of the electric light plant, and it is understood that the capacity will be increased from 5,000 to 10,000 incandescent lights. The plant will be completely overhauled and equipped with new machinery as part of the present outfit will be abandoned.

MINNESOTA.

WADENA.—The village electric light plant is to have a new power house.

CHISHOLM.—The Crowley Electric Company, of Duluth, has secured a franchise for a local lighting plant.

MARSHALL.—The city authorities are arranging to install new boilers in the municipal electric light plant.

DELANO.—The Delano Electric Light Plant will probably erect new pole lines some time between now and fall.

VASSAR.—A new 200-h.p. engine will probably be added to the equipment of the Municipal Electric Light Plant.

ATWATER.—The establishment of an electric light and water plant is reported to be under consideration by the council.

UNION CITY.—It is understood that the Union City Electric Light Plant contemplates installing a new engine and boilers.

WEST BRANCH.—The Rifle River Electric Light Company is planning to increase its equipment by putting in a new water-wheel and alternator.

WINONA.—The Winona Railway & Light Company is displacing its small engines and generators with two Curtis steam turbines and 500-kw. generators.

FARIBAULT.—The Faribault Gas & Electric Company is contemplating several improvements at its plant, among which will be the installation of a steam turbine.

WEST BAY CITY.—City Electric Light Plant is said to be contemplating an extension of its circuits which will necessitate the erection of about eight miles of lines.

BRECKENRIDGE.—The city council is considering the question of increasing the capacity of the Municipal Electric Light and Water Works by installing a 1,000,000-gallon steam pump.

MONTEVIDEO.—It is reported that the Montevideo Electric Light and Power Company, which is owned by Mr. E. A. Aspnes, is to be incorporated shortly and will utilize water power from some nearby source.

SHELBY.—It is reported that the present capacity of the municipal electric light plant is entirely too small to meet the demands of its increased business, and the plant will probably be enlarged and improved in the near future.

ST. PAUL.—Mr. G. S. Edmondstone, chief engineer for the Cannon River Electric Company, states that the company is preparing to build a dam and power house and install hydraulic and electric machinery for developing 2000 kilowatts on Cannon River, near St. Paul.

MISSISSIPPI.

MACON.—The Macon Ice, Light and Power Company is planning to enlarge its plant and equipment.

MERIDIAN.—The Meridian Light and Railway Company is engaged in erecting a new power house for its plant.

OSYKA.—A bond issue of $15,000 for water works and an electric light plant was recently voted for by the citizens.

YAZOO CITY.—The city light plant is making arrangements to operate continuously in order to supply current for fan and other motors.

HATTIESBURG.—The order providing for the sale of $60,000 bonds to construct or purchase an electric light plant has been passed by the Board of Aldermen.

DURANT.—A new plant is in course of construction at Lexington, this state, which will be operated by power furnished from the Durant municipal electric light plant.

STARKVILLE.—New equipment, consisting of one 150-h.p. boiler, a 3000-volt G. E. alternator and a 200-h.p. engine, will probably be installed in the municipal electric light plant.

BROOKHAVEN.—It is expected that a new boiler equipment will shortly be installed at the municipal electric light plant, and the alternators will probably be changed to 60 cycles frequency.

MISSOURI.

SHELBINA.—The Shelbina Electric Light Plant is adding to its lines.

CAMERON.—The municipal electric light plant is putting in a 6.5-amp. enclosed arc lamp circuit.

LIBERTY.—The Liberty Electric Light Plant is to put in a new generator during the coming summer.

BOWLING GREEN.—The power plant of Mr. N. H. Ledford is to be enlarged to three times its present capacity.

ST. LOUIS.—The Carondelet Electric Light and Power Company is putting in 150-kw. units in place of those now in use.

PLEASANT HILL.—Mr. J. O. McAllister states that he is now sole owner and manager of the Pleasant Hill Electric Light Plant.

BLOOMFIELD.—The Bloomfield Electric Light, Heat and Power Company is planning to extend its lines to another town seven miles distant.

DEXTER.—Several improvements to the city light plant will probably be installed and considerable new construction work will be done.

VERSAILLES.—Bids were recently closed for furnishing the necessary labor, material and equipment for the installation of an electric light plant.

HIGGINSVILLE.—It is rumored that the City Water and Light Plant is to be rebuilt and its equipment increased by about 200 horse-power in boilers and engines.

BUTLER.—The municipal electric light plant management contemplates installing two generators, one engine and a boiler, which will be duplicates of the machinery in use at present.

SEDALIA.—It was recently reported that the Sedalia Water and Light Company would consolidate shortly with the Gas Company and the Street Railway Company's lighting plant.

MOBERLY.—The citizens recently voted a franchise to the Moberly Light, Power & Fuel Company for the construction of an electric, gas, power and fuel plant; also a contract to light the city for a period of ten years.

ST. LOUIS.—Mr. Charles F. Foster, vice-president of the National Supply Company, of Chicago, has been appointed chief operating engineer of the immense World's Fair plant which has a capacity of 40,000 horse-power.

JOPLIN.—The Southwest Missouri Light Company, whose headquarters are in this city, recently closed a contract with the Conkey Mining Company, near Webb City, to supply the necessary power for operating its plant.

CHARLESTON.—The Southwest Missouri Ice, Light & Power Company has been incorporated with a capital of $100,000 for the purpose of erecting an electric light plant and ice factory. Among the incorporators are J. E. Armstrong and R. B. Boyce, of Charleston.

ST. LOUIS.—The Western Electric Company had a narrow escape from fire a short time ago. The fire started at the base of a post between the second and third floors of the building, but was discovered before any damage had been done beyond scorching the woodwork.

ST. LOUIS.—Suit was recently instituted by Mr. Morgan Jones, of Denver, Colo., in the United States Circuit Court to set aside the consolidation of the Union Electric Light & Power Company, the Citizens' Electric Light & Power

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Company, and the Missouri Electric Light & Power Company, these companies being now constituents of the North American Company, of New York.

MONTANA.

GLENDIVE.—The Hughes Electric Light Company is arranging for the purchase of a 100-kw, 1040-volt, 133-cycle alternating-current generator some time between now and the fall.

NEBRASKA.

HEBRON.—The Hebron Light, Power and Heat Company is enlarging its plant.

FREMONT.—A new 200-h.p. engine is to be installed in the city electric light plant.

OSCEOLA.—The station equipment of the electric light plant here, owned by Mr. Clarence Miller, has been increased.

LINCOLN.—The citizens recently voted to issue $65,000 bonds for the purpose of constructing an electric light plant.

HOOPER.—The Hooper Electric Light Plant, owned by Mr. William T. Martin, is to be equipped with an additional boiler.

SEWARD.—The Seward Electric Light Plant, which began operation February 2, this year, is already contemplating extension of its service lines.

COLUMBUS.—Mr. A. Heinz, who owns and operates the Columbus Electric Light Plant, expects to put all arc lights on an alternating-current circuit.

BEATRICE.—The Beatrice Electric Company is remodeling its steam plant. Among other improvements contemplated are the erection of a new building and the extension of its service lines.

OMAHA.—The new power house which is being erected by the street railway company is about ready for the installation of the machinery. This work will take some time, however, so that the plant will not be ready for operation very soon. The cost of the new plant is estimated at $500,000.

LINCOLN.—Work on the new plant of the Lincoln Telephone Company was delayed a few days by the strike of the electrical workers employed by the General Engineering Company which has the contract for placing the outside work of the new system. No increase in wages was asked, but the men insisted that the scale should be signed for another year before going ahead with the work.

NEVADA.

TONOPAH.—The Tonopah Light and Power Company expects soon to increase the capacity of its plant.

NEW HAMPSHIRE.

BRADFORD.—The Bradford Electric Light Plant, which is owned by Mr. C. A. Hadley, is contemplating the construction of a three-mile extension.

MEREDITH.—Mr. E. Carleton Mansfield, manager of the Meredith Electric Light Company, was recently in Providence, R. I., for the purpose of consulting with the owner of the plant concerning the wishes of Meredith in regard to the lighting of the streets of the town for the ensuing year.

GARVIN'S FALLS.—The electrical apparatus for the new hydro-electric plant here will consist of General Electric three-phase generators with an aggregate capacity of 6000 horse-power. This power will all be used by the Manchester Traction Light & Power Company, which controls the street railway, lighting and power interests of Manchester, N. H. This company also supplies current for a portion of the Concord & Manchester electric branch of the Boston & Maine Railroad.

NEW JERSEY.

WASHINGTON.—Mr. Charles B. Hindle has petitioned the Council for a franchise for a water, gas and electric light plant.

SAYREVILLE.—The Sayreville Electric Light and Power Company is planning to extend its system in the immediate future.

PARK RIDGE.—A municipal electric light plant will be erected at a cost of $12,000. The plant is to be operated by water power.

MORRISTOWN.—The United Electric Company of New Jersey is contemplating the extension of its underground circuits here.

WASHINGTON.—The Washington Electric Light Company recently added improvements at its station and is reconstructing its service lines.

CAMDEN.—The Baxter Lighting Company was recently incorporated with a capital of $25,000. The incorporators are Lewis S. Baxter, George M. DeGunther and L. Howard Weatherby.

EGG HARBOR.—The Atlantic County Electric Company expects to add 25 enclosed arc lamps to its lighting circuit and the equipment of the power plant will be increased by the installation of a 120-kw. dynamo.

AMPERE.—Upon a vote of three-quarters of the stockholders, the Crocker-Wheeler Electric Company has increased its capital stock by $1,000,000 in order to provide additional capital for its rapidly growing business. One-fourth of this amount was issued to present stockholders, the remainder being kept in the treasury for issue later.

NEW MEXICO.

ALMOGORDO.—The Almogordo Electric Light Plant, which was recently rebuilt, is pushing its motor service.

ROSWELL.—An ordinance has been passed, granting to Maynard Gunsal the right to furnish electricity for power, heat and illuminating purposes in this city.

NEW YORK.

CORTLAND.—The Cortland & Homer Electric Company is preparing to improve and enlarge its plant.

SHERMAN.—The Sherman Electric Light Company is increasing the service capacity of its line wires.

GROTON.—A boiler of 125 or 150 horse-power capacity will be installed in the village electric light plant.

HERKIMER.—The Council is considering the question of a new boiler house for the municipal electric light plant.

ELMIRA.—Elmira Water, Light and Railway Company is said to be arranging for the installation of a 1400-h.p. gas engine.

GOUVERNEUR.—A franchise for the construction of an electric light plant has been granted to J. Henry Abbott.

MEXICO.—The Mexico Electric Light Company expects to add a new water-wheel to its power equipment.

WATKINS.—Plans are under way for the construction of a village lighting system at a cost not to exceed $20,000, it is said.

FRANKLINVILLE.—The Empire Electric Company recently installed a direct-current dynamo for supplying power to stationary motors.

CHATEAUGAY.—The Chasm Power Company is preparing to run a line to Burke, five miles from here, for light and power transmission purposes.

SPENCER.—The Spencer Electric Light Plant, owned and operated by Mr. S. A. Seeley, is to be equipped with a new boiler, a feed-water pump and a heater.

MIDDLEPORT.—The Albion Electric Light and Power Company is said to have secured the contract for lighting the city by electricity at $60 per lamp per year.

ELIZABETHTOWN.—The Elizabethtown Electric Light Company is increasing its water power facilities and recently put in a 360-ft. extension of 18-in. steel tube.

SCHENECTADY.—Recent reports show that the Schenectady Railway Company, which has the contract for lighting the city, has made considerable improvement in the service.

DUNDEE.—The Dundee Electric Light, Heat and Power Company, owned by Mr. E. L. Bailey, is said to be planning an extension of its lines to the town of Lakemount, three miles distant.

GOWANDA.—According to recent reports, the plant of the Consolidated Electric Light and Power Company which has heretofore been run by means of a gas engine, will be operated by water power in the future.

MANLIUS.—Articles of incorporation have been filed by The Manlius Gas & Electric Company, with a capital stock of $10,000. M. Murphy and William Murphy, of Manlius, and G. M. Corwin, of Oswego, are the directors.

BUFFALO.—The Bison Motor Company was recently incorporated with a capital of $25,000. Mr. Frederick Wende and Mr. W. A. Lutz, of Buffalo, and Mr. F. I. Alliger, of Tonawanda, are named as directors of the new company.

BATAVIA.—Mr. Edward C. Atwater, receiver of the Consolidated Gas & Electric Light Company, was recently granted permission by the Supreme Court to discontinue the manufacture of gas as the expenditures exceeded the receipts.

MT. MORRIS.—The Mt. Morris Electric Light and Power Company is planning to enlarge and improve its plant. A direct-current day circuit will be added to the present system, the power being supplied from direct-connected units.

PORT DICKINSON.—Walter Moore & Co., of Binghamton, have petitioned for a franchise to string power wires through this place. They desire to erect poles and string wires from the new power plant on Mill Street to the Binghamton city line.

CASTILE.—The municipal electric light plant finds its necessary to construct more new lines in order to meet the increased demands of the village lighting service, and it is understood that another unit is to be installed at the power house.

NIAGARA FALLS.—Mr. Robert E. Drake and Mr. Paul T. Brady, of Syracuse, are reported to be interested in the Niagara Falls, Lockport & Ontario Power Company, which proposes to supply electric power to as many cities in the State as desire it.

BUFFALO.—Bill of complaint was recently filed against the International Trolley Controller Company, of this city, by the Westinghouse Electric & Manufacturing Company on the grounds of infringement of two electrical patents owned by the latter company.

SCHENECTADY.—The Schenectady Railway Company has been engaged for several months in placing all its cables and wires in conduits. The work is nearing completion and it is expected that in a short time all their power will be distributed through the underground circuit.

WATERLOO.—The village trustees have been petitioned by the Senaca Edison Company for renewal of its franchise. The company, it is said, contemplates replacing the present lights with improved lamps such as are now being used in Geneva and Senaca Falls, as soon as the new franchise is granted.

WATKINS.—It is reported that the property and franchise of the Watkins Consolidated Gas & Electric Company have passed into the hands of the United Power & Traction Company, with headquarters in Philadelphia. It is thought that the recent action of the village in voting for a municipal lighting plant led to the sale.

ROCHESTER.—The Clark Syndicate, which controls the Rochester Railway Company, is reported to be negotiating for the purchase of the Rochester Gas & Electric Company. The railway company now obtains 1000 horse-power from the electric company. Extensive water rights are owned by the latter concern, many of which are undeveloped and which could be utilized for the generation of a large amount of power.

NEW YORK CITY.—About 11,000 of the wires running to the Cortlandt Street exchange were recently damaged by fire which originated in the Broadway subway. About one-quarter of the subscribers in this district were cut off from the exchange and several trunk lines to other exchanges were involved, as well as the long-distance lines to Boston, Providence, New Haven, other New England points, and to Buffalo.

UTICA.—At the annual meeting of the stockholders of the Utica Gas and Electric Company, held recently, the following officers were reelected: President, A. N. Brady; vice-president, William E. Lewis; secretary, W. J. Cahill; treasurer, George H. Stack; general manager of gas department, W. J. Cahill; general manager of the electric department, M. J. Brayton. It was said recently that the company expected to put in additional boilers and a 1500-kw. steam turbine.

BROCKPORT.—For some time the electric light service furnished by the Albion Electric Light & Power Company has been more or less unsatisfac-

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tory. At times the service failed completely, notwithstanding the frequent assurances of better service. The Village Board had the lights examined by an electrical expert, who reported that the lamps were not being supplied with the proper voltage to give the required candle-power. This report was submitted to Mr. Wallace C. Johnson, vice-president and general manager of the company, and he stated that he would have the lights examined himself and if he found that they were not receiving the proper voltage to fill the contract he would not attempt to hold the village to their part of the contract.

ILION.—According to the report submitted by the Board of Light Commissioners of the transactions of the municipal lighting plant for the eleven months ending March 1, 1904, the receipts including an appropriation of $7000.00 were $13,822.60; the disbursements, including maintenance, accounts prior to April 1, 1903, and bond and interest, amounted to $20,139.04, showing a deficiency of $6,316.14. This large deficiency, the Board explains, is due meters having been purchased, to the item for old accounts paid by the commission amounting to $2,985.25 and to the fact that the light furnished for public services for which no remuneration is received, would at current rates add nearly $400 to the income of the plant. The estimate given for the coming year shows a deficiency of $9,000, which the commissioners ask to have included in the appropriation.

NORTH CAROLINA.

FREMONT.—The council is considering the matter of establishing an electric light plant.

TARBORO.—The municipal electric light plant will probably extend its incandescent lighting circuit.

SOUTH PINES.—The South Pines and Carthage Electric Plant is considering the question of increasing its power plant equipment.

GOLDSBORO.—It is expected that a 300-h.p. electric light plant will soon be installed here, equipped with the necessary engines, dynamos and boilers.

WAYNESVILLE.—Contract has been let for developing 1000 horse-power on Pigeon River for B. G. Sloan, proprietor of the White Sulphur Springs Hotel. The power will be transmitted to Waynesville, where it will be utilized for lighting and other purposes.

JONESBORO.—Mr. A. F. Spencer, of Sanford, N. C., is said to have secured the franchise for light, heat and power for this place, and it is understood that the lights will be put in very soon. He has also secured the contract for lighting the streets with arc and incandescent lights for a term of five years.

NORTH DAKOTA.

VALLEY CITY.—At a recent election the citizens voted not to sell the electric light plant.

MANDAN.—The Mandan Electric Company contemplates erecting new poles and putting in larger wires.

KENMARE.—Mr. A. B. Kerlin, of Devil's Lake, has been granted a franchise to put in an electric light plant here.

LANGDON CITY.—The electric light company here is considering extending its lines, for which purpose it will be necessary to erect a new power house and install additional equipment.

OHIO.

COLLINWOOD.—The municipal plant of this place is to add another boiler to its equipment.

READING.—The municipal electric light plant, according to a recent report, will be enlarged one-half.

LONDON.—The municipal electric light plant has adopted series enclosed arc alternating-current street lamps.

BEREA.—The Berea Water Works and Electric Light Plant is building a wall for the protection of the reservoir.

CHARDON.—It is expected that the Chardon Electric Light Works will shortly install a new heater and steam separator.

GREENFIELD.—The Greenfield Corporation is changing the type of lamp used for street lighting from open to enclosed arc.

NILES.—The City Electric Light and Water Works are to have a new building, it is said. A new boiler, engine, heater and piping system will also be installed.

WAPAKONETA.—Bonds to the amount of $7000 have been sold for the purpose of making improvements to the electric light plant and water works.

BELLEVUE.—It is understood that the Bellevue Light and Power Company is to rebuild its power plant and change the lighting system to enclosed arcs.

CLYDE.—Additions to the equipment of the municipal electric light plant, consisting of two 100-h.p. boilers and one 100-h.p. Corliss engine, are said to be under consideration.

SOUTH BROOKLYN.—The municipal electric light plant is to be equipped with an engine and generator to supply the additional power required for the day circuit which has recently been added to the system.

ASHLAND.—The question of whether it would be better to establish a municipal electric light plant or renew the contract with the present company is being discussed. The city is now using 68 arc lamps at $81.00 per lamp per year.

SHELBY.—It is reported that $20,000 have been spent by the city for improvements, enlargements and extensions to the municipal plant since 1892. The streets are lighted all night with 72 arc lights and the city buildings contain 250 incandescent lights.

WEST ALEXANDRIA.—The addition to the power house of the Dayton & Western Traction Company, which has been in course of construction for some time, is about completed and is being equipped with new machinery of the most improved type.

HILLSBORO.—On April 30 bids were opened for furnishing electric arc lights for lighting the streets and incandescent lights for private consumers. The lights for public purposes are to be furnished for a period of ten years.

YOUNGSTOWN.—The Shenango Valley Electric Light Company is now owned by the Youngstown-Sharon Railway and Light Company. Power is furnished by the Youngstown Consolidated Gas and Electric Company, on a 24-hour basis, at 2000 volts over a two-phase circuit.

ALEXANDRIA.—All the equipment for the addition which is being erected at the power station of The Dayton & Western Traction Company has been purchased. The new machinery to be installed includes two 450 horse-power Hamilton Corliss engines, two 250-kw. generators and two 250 horse-power boilers.

PAINESVILLE.—The municipal electric light plant is said to be supplying 100 arc lights for street lighting at an average cost of $69.00 per lamp per year. The plant is said to have a bonded indebtedness of only $1000, the enlargement and extension of the service having been made from year to year without the issue of bonds.

DAYTON.—The ordinance granting a franchise to the Dayton Electric Light Company has been vetoed by Mayor Snyder, for the reasons, it is said, that the company has failed to keep its contract with the city as to prices for commercial lighting and power and that the ordinance does not provide for the placing of wires underground, besides other reasons.

TOLEDO.—The Toledo Railway & Light Company is erecting an addition to the boiler house at its main power station in Toledo. The building will be 45 x 73 feet, and an additional stack will be erected. The company has placed a contract for four 650-h. p. water-tube boilers, and will also install an overhead storage system, coal conveyors and automatic stokers.

TROY.—According to recent reports, the municipal electric plant of this place is a credit to the city. Since purchasing the plant from the lighting company in 1897, the city has spent $36,000 in improvements, all of which has been paid for from the receipts. The number of street arc lights has been increased and 165 incandescent lamps have been put in public buildings.

FREMONT.—Capitalists of this city, Chicago, Waterloo and Auburn, Ind., recently incorporated the Fremont Power & Light Company with a capital of $350,000. The company will establish a water-power electrical plant in Ballville, one mile south of here, on Sandusky River, and for this purpose it has acquired the river frontage on both sides of the river for two miles. It is reported that the company has also combined three private water powers which will be merged into one large power plant.

ST. MARYS.—The Board of Public Service has asked the city council to make an appropriation for the improvement of the Water Works and Electric Light plant. The improvements they desire to make consist of two new water-tube boilers of 300 horse-power each, automatic stokers for two boilers, one heater and purifier of 600 horse-power capacity, one smoke stack, one dynamo, 100 enclosed arc lamps, one air compressor; the drilling of three new water wells, and the repair and extension of electric lines and water mains.

OKLAHOMA TERRITORY.

EL RENO.—Henry T. Smith, Robert S. Trulock and Ernest E. Blake, all of this city, recently incorporated The Union Light & Power Company, with a capital stock of $250,000.

OREGON.

HILLSBORO.—The City of Hillsboro is reported to be extending its lighting system.

McMINNVILLE.—A new engine is to be installed in the municipal electric light plant.

BAKER CITY.—The Baker City Gas and Electric Company is contemplating the addition of twenty miles of pole line.

PENDLETON.—The Northwestern Gas and Electric Company is said to have asked for a 25-year franchise.

PENDLETON.—It is understood that the Pendleton Electric Light and Power Company has been purchased by the Washington and Oregon Power Company, which is erecting a large power plant on the Walla Walla River, Washington.

MILTON.—It is reported that Mr. G. A. Barrett, of the Oregon and Washington Electric Power Company, has announced that contracts have been let for the apparatus and construction of a new plant to be installed here. It is expected that the plant will cost about $250,000.

SILVERTON.—The plant of the Union Light and Power Company is being rebuilt. It is stated that when the new plant is completed, the company will furnish power for the Citizens' Light and Traction Company, of Salem. The power will be supplied over a three-phase transmission line at 15,000 volts.

PENNSYLVANIA.

BEDFORD.—The Bedford Electric Light and Power Company expects to install new arc lamps shortly.

CONSHOHOCKEN.—The Conshohocken Electric Light and Power Company is extending its power circuit.

HYNDMAN.—The Hyndman Electric Light, Heat & Power Company expects to install a new engine shortly.

MECHANICSBURG.—The United Electric Company is reconstructing its power plant and installing new equipment.

WILMERDING.—The Wilmerding Electric Light Company has purchased a site upon which it proposes to erect a power plant.

BERLIN.—The Borough of Berlin has recently installed new power and electrical apparatus which is a duplicate of the old equipment.

SOUTH BETHLEHEM.—Bids were recently asked for to light the town by electricity for a term of five years from June 20, 1904.

MADVILLE.—It is rumored that the old machinery of the municipal electric light plant is soon to be replaced by an entire new equipment.

EBENSBURG.—The Ebensburg Light, Heat and Power Company expects soon to enlarge its equipment by the addition of another 200-h.p. engine.

CLEARFIELD.—The Central Pennsylvania Light and Power Company is adding a new water-tube boiler to its equipment and extending its circuits.

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CHRISTIANA.—A. J. Melchen, who owns the electric light plant here, is preparing to extend his service so as to include fifteen miles of farm districts and three adjoining towns.

LANSDALE.—Improvements will be made to the municipal electric light plant at an early date, consisting of a 120-kw. alternating-current machine, 250-h. p. Corliss engine and a boiler.

NEW FREEDOM.—It is proposed to construct an electric light plant and water works here at an estimated cost of $13,600. Mr. H. K. McKay, of Baltimore, Md., is the engineer in charge of the work.

LEWISTOWN.—The Lewistown Electric Light Company has secured the contract for arc instead of incandescent lights, at $65.00 per light. The company contemplates some additions to the power equipment during the coming summer.

OAK GROVE.—The work of stringing the light wires from Jersey Shore to Oak Grove, a distance of eleven miles, is well under way. The Jersey Shore Street Electric Railway Company has the contract for lighting the town and is pushing the work as rapidly as possible.

EASTON.—At the annual meeting of The People's Electric Light & Power Company, the following directors were re-elected: Dr. E. W. Evans, John S. Osterstock, F. G. Ormsby, S. R. Bush and M. H. Jones, of Easton; G. B. Garrison, New York City, and W. H. Walter, Phillipsburg. Dr. Evans was re-elected president, Mr. Osterstock treasurer and Mr. Ormsby secretary of the company.

SHENANDOAH.—At a meeting of the stockholders of the People's Light, Heat & Power Company, of Shenandoah, and the People's Light, Heat & Power Company, of Mahanoy Township, it was agreed to merge the two companies into one and erect a plant with sufficient power to furnish light, heat and power to Shenandoah, Mahanoy City and other nearby towns. The plant will be located about midway between Shenandoah and Mahanoy City.

YORK.—The plant of the York Haven Water and Power Company, which was recently wrecked by the ice, is to be rebuilt as soon as the temporary structures necessary for the shelter of the machinery are completed. The foundations will be constructed of granite, and solid masonry will supersede the brickwork in the old building. The lines to this city have been complete for some time, awaiting the completion of the temporary buildings, and it is now expected that they will be in use by June 1.

RHODE ISLAND.

WESTERLY.—The Westerly Gas and Electric Light Company expect to erect a new plant this year, thereby doubling the present capacity.

SOUTH DAKOTA.

REDFIELD.—The municipal electric light plant is about to add to its steam equipment.

WEBSTER.—The municipal electric light plant, of this place, will increase its equipment by the addition of new engines and generators, and is engaged in the work of line extension.

BELLEFOURCHE.—The citizens are contemplating the construction of an electric light, heat and power plant at a cost of about $8000. A company is being formed for the purpose, and plans are being drawn for the proposed plant.

TENNESSEE.

DAYTON.—The plant of the Dayton Lighting & Power Company is being rebuilt.

LAWRENCEBURG.—The city council is investigating the cost of establishing an electric light plant.

COLUMBIA.—Bids for furnishing Columbia with 60 arc lights for a term of ten years have been advertised for.

RIPLEY.—The Ripley Light and Water Company is contemplating the installation of a 12 x 36 Corliss engine and a number of transformers.

CHATTANOOGA.—The mayor and city council are said to be considering the question of municipal ownership of the electric light plant.

UNION CITY.—The Union City Water and Electric Light Works has enlarged its system by the addition of a day circuit for the purpose of supplying fans and other motor power.

NASHVILLE.—The Nashville Railway & Light Company has just installed at its plant, in conjunction with a 1600-kw. engine-driven three-phase alternator, a 500-kw. rotary converter. This will enable them to supply both direct current for railway power purposes and alternating current for lighting circuits.

CHATTANOOGA.—It is reported that the General Electric Company, which owns a controlling interest in the Chattanooga Electric Company, is about to establish a model station here. Four new Curtis steam turbines of 500 kilowatts each have been installed in the power house of the Chattanooga Electric Company, and it is expected that with this additional power the entire system of the Chattanooga Electric Railway Company will be operated from the power house of the electric company. The company is also preparing to install a new series alternating-current system of enclosed arc lamps, the current for which will be supplied by constant-current transformers located in the plant.

TEXAS.

BRYAN.—It is expected that Bryan will soon have an electric light and power plant, as a franchise was recently granted to H. B. Dorsey for the erection and operation of such a plant.

ROCKDALE. — The Rockdale Improvement Company is considering the question of increasing the service voltage of its lines from 50 to 110 volts and a general over-hauling of the plant.

SOUR LAKE.—The city council is considering two applications for franchises to establish an electric light plant and water works here, one by Messrs. Sloane, Maxwell and McVeigh, of this place, and the other by Mrs. C. W. Allen, of Houston.

SHERMAN.—The Sherman Light and Power Company has been organized with a capital stock of $100,000. The incorporators are J. Lobit, of Galveston; E. P. Bomar, of Gainesville; W. P. Brents, M. B. Pitts and C. N. Roberts, of Sherman.

UTAH.

LOGAN.—The citizens recently voted to issue $12,000 bonds in order to complete the municipal electric light plant.

PAYSON CITY.—A new alternator of 75 or 100 kilowatts capacity, with the necessary transformers, is to be installed in the Payson Electric Light Plant.

HYRUM.—The Union Electric Light and Power Company is considering the construction of a five-mile line, and will probably erect another tower of the same size as the present one.

RENO.—The franchise and property of the Reno Traction Company recently changed hands by purchase, and it is understood that work on the prospective road will soon be under way.

CASTLEDALE.—The Town Boards of Castledale and Orangeville are considering figures submitted by W. E. Raines, of the Salt Lake Electric Supply Company, Salt Lake City, for the construction of an electric light plant to be used for lighting both towns. The cost of the plant is estimated at $10,000.

SALT LAKE CITY.—The Standard Power Company was recently incorporated with a capital stock of $1,000,000. The company purposes establishing a power plant on the Sevier River in the southern part of the state and it is expected that the work will be commenced early during the present season. The plant will have a capacity of about 5000 horse-power and will cost $500,000.

LOGAN.—The Hercules Power Company has announced its intention of cutting its price to 15 cents each per month, or to 5 cents each if necessary. If this should be done, it is feared that the evident determination of the city administration to have politics figure in the operation of the municipal plant can but result in the destruction of a plant which will have cost Logan City, when completed, not less than $100,000.

VERMONT.

BURLINGTON.—Articles of incorporation have been filed by the Northern Electric Company. The new corporation has a capital stock of $20,000 it is said.

HARDWICH.—The necessary changes are being made in the village light and power plant to increase the power capacity of the plant.

VIRGINIA.

WOODSTOCK.—The Woodstock Electric Light & Power Company has been incorporated with a capital stock of $2000 to $10,000.

RICHMOND.—Mr. C. E. Bolling, superintendent of water works, in his annual report estimates the cost of constructing an electric light plant at about $150,000.

FREDERICKSBURG.—Cartright & Davis, of this place, state in regard to the development of water power that only work of a necessary character will be done at once, as the details of improvements will probably not be completed by the engineer, Mr. Charles Ruffin, for several months.

LYNCHBURG.—The Lynchburg Traction and Light Company states that it has in the course of construction a water power station of 4000 horse-power capacity. Three 750-kw. G. E. generators will furnish current at 13,200 volts. It is expected that the plant will be in operation by August next.

RICHMOND.—According to a recent report the street railway company here has announced that hereafter it will enforce the law which permits conductors to separate white and negro passengers. Any persons failing or refusing to observe the orders of the conductor will be liable to a fine of $25.00 and may also be ejected from the car for such refusal.

NORFOLK.—It was recently decided to dissolve the Norfolk, Portsmouth & Newport News Company, comprising the Berkley Street Railway Company and the National Gas Company, of Berkley; the Old Dominion Railway Company, of Portsmouth, and the Norfolk County Ferry Company. It is understood that the dissolution was entirely amicable. The various companies did not find the arrangement a profitable one, and all concerned agreed that a larger profit could be made by the individual operation of the several industries.

WASHINGTON.

SEATTLE.—The American Improvement Company has petitioned the Council for a franchise.

KALAMA.—The Kalama Electric Light and Power Company will put in a complete telephone system for the town.

MONROE.—The Monroe Water and Light Company, recently organized, will install a complete electric light plant and water system.

FORT WRIGHT, SPOKANE.—A new electric plant is to be installed here for the purpose of supplying light and power to the Post.

BELLINGHAM.—The City Council has granted to the Whatcom County Railway and Lighting Company a franchise for its Elk Street extension.

TACOMA.—The plant of the Kent Electric Light Company is now understood to be the property of the Puget Sound Electric Company, of this city.

ANACONTES.—The Anacontes Water Power Company contemplates enlarging its equipment by the addition of new boilers and will also build a new boiler house.

BELLINGHAM.—The City Council has decided to install a municipal electric light plant, using the power of the Whatcom Creek Falls. The estimated cost is $17,000.

WEST SEATTLE.—An election will soon be held to decide the question of town ownership of an electric street railway system. If carried, a system will soon be installed.

OLYMPIA.—The Olympia Light and Power Company is asking the City Council for a franchise to extend its Fourth Street line to the city limits, the extension to be complete in one year.

DAVENPORT.—Mr. John A. Hanson, of this city, is reported to have under consideration the construction of an electric line from Reardon to Edwall, and is understood to have also secured a franchise to enter Spokane.

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SPOKANE.—The Washington Water Power Company proposes to extend its street railway line to the city limits in order to make better connection with suburban lines and has made application for a franchise permitting it do so.

PORT ANGELES.—The articles of incorporation of The Port Angeles Water and Power Company place the capital at $150,000 in shares having a par value of $20 each. H. A. Lingenbrink, George B. Reid and W. F. Delabarre, all of this city, are named as trustees.

BELLINGHAM.—The Bellingham Bay Improvement Company, which has just secured the contract for lighting the city, is erecting a plant capable of developing 1000 horse-power at the falls of Nooksack River, and is preparing to erect fifty miles of transmission line.

BALLARD.—The Ballard Electric Company has under construction a new station of 1000 horse-power capacity. The plant will be housed in a fire-proof building of brick and steel construction, and is to include only modern equipment of the most improved type.

CHEHALIS.—The Council is considering the question of leasing the electric light plant for another fifteen years to Mr. Harry West, the present lessee. The property is owned by the city, but has been leased for several years by Mr. West. It is thought probable that his lease will be renewed.

BALLARD.—A franchise to furnish electric light and power at Ballard has been granted to Mr. H. A. Starkey. The franchise was amended to provide that the electricity should be generated here, the plant to be completed in six months and to cost $40,000. The term of the franchise is fifty years.

SEATTLE.—The Seattle Lighting Company was recently organized by Messrs. Lyman C. Smith and William Nottingham, of Syracuse, N. Y., and Mr. J. W. Clise, of Seattle, with a capital of $4,000,000. It is reported to have taken over the plant of the Seattle Gas & Electric Light, which will be consolidated with the Citizens' Light & Power Company already owned by the new company.

WALLA WALLA.—The engineers for the large power plant of the Washington and Oregon Power Company are at work on the site of the power station which is located on the south fork of the Walla Walla River, near Milton. It is the intention to have the plant in operation by October 1. The company contemplates furnishing light and power to all of the country between here and Pendleton, Ore. A main power line will be run both ways from the plant to the two cities and branches will be run into the towns lying along these main lines. The new company, it is stated, has bought out the Walla Walla Electric Light Company and the Pendleton Electric Light and Power Company.

SEATTLE.—The preliminary test of the power plant of the Columbia Improvement Company at Electron, which is now nearing completion, is said to have shown very satisfactory results. The tests were conducted with power transmitted from the Post Street station of the Seattle Electric Company, Under the direction of Mr. Lukes, lighting and power superintendent, of the Seattle Electric Company, 60,000 volts were turned into the transformers in the new power station; the machines stood the test satisfactorily. It is expected that the full capacity of the plant will have been developed by August 1 next, and it is stated that the entire supply of current will be used by the Seattle Electric Company in conjunction with that already being received from the Snoqualmie Falls Company.

WEST VIRGINIA.

PARSONS.—The Parsons Electric Light & Power Company is contemplating the installation of an auxiliary steam power plant.

WESTON.—The Weston Electric Light, Power & Water Company states that it expects to double the capacity of its plant this summer by the addition of either a turbine or direct-connected gas engine.

WISCONSIN.

MILWAUKEE.—The citizens have voted to issue $500,000 for a municipal lighting plant.

WAUSAU.—The contract for building a new electric light plant to cost about $20,000 has just been let.

GRAND RAPIDS.—The Electric & Water Company of Grand Rapids expects to enlarge its circuits and reconstruct its pole lines.

FENNIMORE.—It has been decided by the City Council to install an electric light plant in connection with the city water works.

FOUNTAIN CITY.—H. & F. Roettiger, owners of the electric light plant of this city, are thinking of adding another dynamo to their equipment.

LADYSMITH.—The power plant of the Ladysmith Electric Company, which was burned recently, is to be rebuilt shortly at a cost of $5,000.

ANTIGO.—The Antigo Electric Light Plant, formerly owned by W. L. Elliott, who died recently, will be sold as soon as Mr. Elliott's estate is settled up.

HARTFORD.—The Hartford Electric Company expects to secure the contract for city street lighting this summer, which would necessitate a considerable change in the plant equipment.

LAKE GENEVA.—The Lake Geneva Water and Light Company has a contract with the city for 25 lights of 1200 nominal candle-power. The lights are run on the moonlight schedule and until midnight.

MANITOWOC.—William Rahr, Sr., and William Rahr, Jr., are the incorporators of The West Side Electric Power & Lighting Company, recently organized with a capital of $25,000 to furnish power and light to manufacturing plants.

MANITOWOC.—The Electrical Construction Company, of Racine, has secured the contract for installing a complete electric plant in the factory of the Manitowoc Malting Company, which is said to have an annual capacity of a million and a half bushels and to be the largest concern of the kind in the world.

CANADA.

BURKS FALLS, ONT.—The McKnight Bros. Co. is planning to enlarge both its plants.

MOOSE JAW.—Bids will be received May 14 for an electric lighting system and engines.

ACTON, ONT.—The municipal electric plant is preparing to put in a day circuit for power purposes.

ORANGEVILLE, ONT.—The Orangeville Electric Light and Power Company recently installed a gas engine as prime mover.

CARLETON PLACE, ONT.—The Carleton Place Electric Light Company proposes to increase the capacity of its plant this season.

PORT HOPE, ONT.—The Port Hope Electric Light & Power Company intends to add another 150-kw. alternator to its plant equipment.

NEWMARKET.—The Corporation of Newmarket is installing a small direct-connected unit at its plant for carrying the load after midnight.

KENTVILLE, N. S.—The Kentville Electric Light & Power Company contemplates installing a small engine and dynamo to run after ten o'clock.

CORNWALL, ONT.—The Stormont Electric Light and Power Company is putting in a new power circuit connected with the Mille Roches power house.

THREE RIVERS, QUE.—The North Shore Power Company is arranging to duplicate the line from its power house to this city, a distance of twenty miles.

OWENS SOUND, ONT.—The Owens Sound Electric Department is considering the advisability of changing from direct to series alternating current for street lighting.

ELLIOTT'S FALLS, ONT.—The electrical equipment for the transmission plant here, which was installed by the Canadian General Electric Company, is now complete.

OTTAWA.—The question of placing the overhead wires in underground conduits is being considered by a sub-committee of the City Council and representatives of the Consumers' Electric Company. Congestion in the busiest thoroughfares will make it necessary sooner or later to remove the poles and wires from these districts.

NANAMIO, B. C.—The City Council has received a communication from Mr. C. Brandies, electrical engineer, representing a Montreal syndicate, asking for a charter for the construction of an electric street railway system. The company also proposes building a suburban line between this city and Brechen at the newly discovered coal fields of the Western Fuel Company. The power will be derived from the Nanaimo River Falls.

WINNIPEG.—The Great Lakes and Northwestern Transportation Company recently filed incorporation papers, with a capital of $10,000,000 fully subscribed. The company was organized for the purpose of supplying electric power to the city of Winnipeg and surrounding towns and municipalities, but the incorporation also permits the construction of canals and other improvements in navigation between Lake Superior and the Red River to a point south of Winnipeg, the construction of transportation lines, and general improvements in the navigation of the lakes and rivers of the Canadian Northwest.

MEXICO.

LAGOS, JALISCO.—The construction of a municipal electric light and power plant is contemplated.

VICTORIA.—Manuel Gonzalezhys has secured a concession from the State Government for the establishment of a water power plant.

SAN ANGEL, FEDERAL DIST.—S. Robert & Cia. are making preparations for the installation of a new water power plant here of 250 kilowatts capacity.

REAL DEL MONTE, HIDALGO.—This place is soon to have an electric light and power plant. The enterprise is being backed financially by the State Government.

AGUASCALIENTES.—The Cia de Luz and Fuerza Electricas is about to make a change in its lighting system. Alternating current series arc lights will be used instead of series incandescent lamps.

TEOCALTICHE, JALISCO.—Application has been made to the state authorities by Longinos Gonzales for permission to establish an electric light and power plant here. The plant will be operated by steam.

PURIFICACION, JALISCO.—The Rosa Amarillo Company, which is being organized to develop timber land in the Cautitlan district, will also construct a large electric power plant to furnish power for an electric railway and to operate small smelters.

ZACATLAN, PUEBLA.—Plans for the erection and operation of an electric light and power plant have been submitted by the City Council to the State Department for formal approval, and it is thought that work on the plant will be begun in a short time.

SAN CHRISTOBAL, CHIPAS.—Mr. F. J. Marley, representing an American syndicate, has applied to the Mexican government for permission to establish an electric power plant for the purpose of supplying light and power for the city of San Cristobal and towns in the vicinity.

ZITACUARO.—It is reported that the Guanajuato Power Company, which is at present furnishing power to mining companies of Guanajuato, contemplates establishing a plant at this place for the purpose of conveying power to the El Oro mining camp. The company is constructing a line to Irapauto.

MONTEREY.—The Monterey Light and Power Company has been incorporated by New York capitalists, under the laws of the State of New Jersey, with a capital stock of $500,000. They have acquired the extensive electric light and power plant here and it is understood that it will be remodeled and enlarged. Mr. P. G. Gossler, head of the operating department of the electrical engineering and contracting firm of J. G. White & Co., New York, is president. About 1100 kilowatts of new machinery will be installed in the plant, which includes a 500-kw. Curtis turbine-generator outfit, two 240-kw. belt-driven alternators, a 125-kw. engine-driven exciter and two small belted exciter generators, together with 150 fan motors. Babcock & Wilcox boilers will be used. The work of remodeling and extending the system will be carried out by J. G. White & Co.

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A RAPIDLY GROWING WESTERN CENTRAL STATION.

THE GENERATING PLANT OF THE KANSAS CITY ELECTRIC LIGHT COMPANY.

BY E. A. BARTH.

It is not uncommon of late years to hear from central station managers that the contracting department is securing additional load faster than the operating department can take care of it. The plant here described, which supplies the central station lighting of Kansas City, Mo., and Kansas City, Kan., deserves special mention in this respect. The remarkable growth of its business from 1899 to the present is illustrated by the curves in Fig. 2, which show the load on the stations of this company on corresponding Saturdays in December for the past five years. From this it is seen that from a maximum of 900 kilowatts in 1899 the load has grown to a maximum of over 3400 kilowatts in 1903. The greatest increase was recorded between 1900 and 1901. The phenomenal increase is due partly to management and partly to the great growth and prosperity of Kansas City during the past five years.

At the time the present management assumed charge, the property consisted of a number of comparatively small and uneconomical plants containing almost every type of machine arranged in nearly every conceivable way as regards belting and shafting. The manner in which this tremendous increase of load was taken care of while permanent improvements were going on is an interesting story in itself. It was out of the question to install permanent improvements fast enough each year to take care of all the load, and many make-shifts had to be resorted to; each move, however, be-

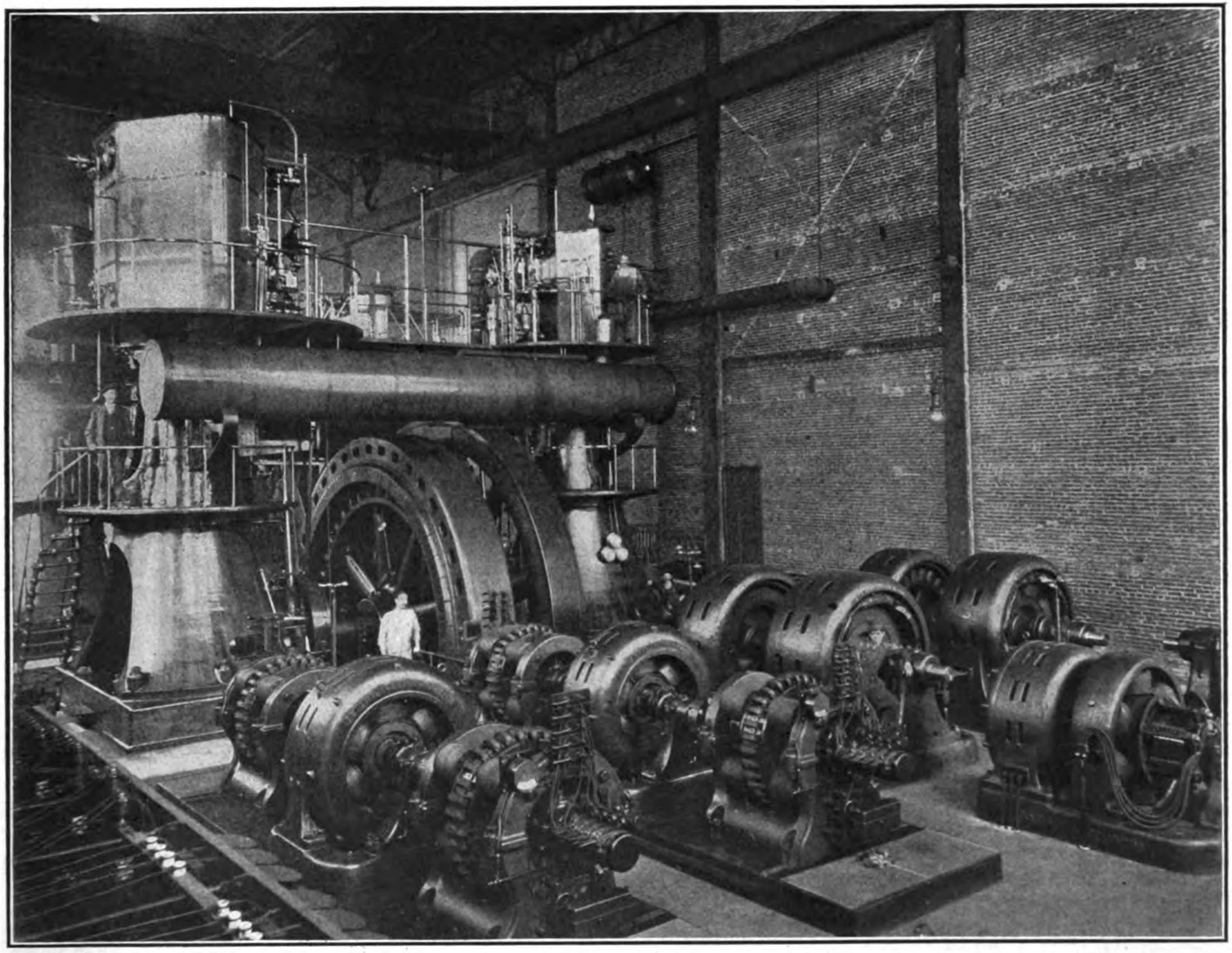

FIG. I.—CENTRAL STATION OF THE KANSAS CITY ELECTRIC LIGHT COMPANY.

ing in the direction of greater economy of operation and the centralizing of generating stations. In order to show what an undertaking the management had before it in June, 1900, a brief summary of the equipment at that time is given.

At the Wall Street station, in the center of the city, was a direct-current Edison plant. Like most of the early Edison stations supplying a low-tension three-wire net work in the central districts of large cities, it was built with a view to economizing ground space. On the lower floor were four B. & W. boilers rated at 200 horsepower each, and on the same floor with these boilers were seven high-speed engines. On the upper floor and belted to the engines were two 45-kw. and eight 60-kw Edison bi-polar generators, and one 500-volt generator for power purposes.

At the South plant, which supplied both series arcs and alternating current incandescent circuits was another two-story station. On the lower floor of this were three B. & W. boilers rated at 250 horse-power each and one of 300 horse-power. There were two cross-compound Allis engines, two Smith Corliss engines, and one Westinghouse compound high speed engine. Driven from various lines of shafting on the second floor were two 75-kw. 1000-volt 133-cycle Westinghouse alternating-current generators, nine 60-light Wood arc dynamos, seven 50-light T-H arc dynamos, one 35-light T-H and six 30-light T-H arc dynamos.

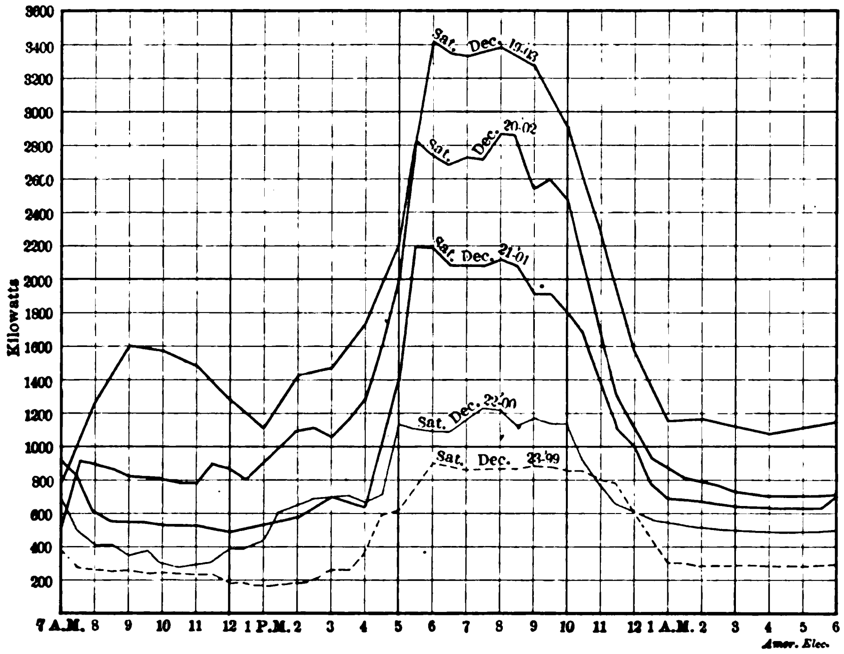

FIG. 2.—CURVE SHOWING CORRESPONDING LOADS FOR FIVE YEARS.

The West plant, which also supplied both arc and constant potential alternating current, was located in Kansas City, Kan. It had three B. & W. boilers rated at 95 horsepower, one St. Louis Corliss engine, two 35-kw. 1000-volt, 133-cycle Westinghouse, alternating-current generators, one 100-light Brush arc dynamo and one 25-light Ball arc dynamo. This made a total of 42 dynamos scattered through the three plants.

To distribute current on the Edison net work in the business district, overhead mains from No. 6 to No. 000, and feeders from No. 000 to No. 0000 and 500,000 circular mils were used. The old style chemical meter was used in this district. The arc lines were in very poor condition, having single petticoat insulators. All kinds of open arc lamps were on the circuits, and three men were kept busy repairing arc lamps. All the copper used in the alternating current distribution was very light and consequently there was a large drop in voltage. Shellenberg meters were used. The lines were separated as far apart as possible, evidently with the idea of increasing the insulation between them, and the majority of the poles were in bad condition.

One of the first temporary changes made was the installation at the South plant, of two 100-kw. Wagner step-up transformers which raised the voltage from 1000 to 2000 volts, thereby decreasing the line loss. This 2000 volts was to be the final standard voltage on this distribution. At the same time the transformers were all changed to G. E. 60-cycle.

On account of shortage of power on the Edison system down town, a Helios-Upton storage battery was installed at the Wall Street plant. This battery was installed rather than more generating machinery because quick delivery could be made. Two 100-kw. bi-polar Edison generators were also put in at this plant. The load on the system increased so rapidly from the start that before the winter was over, the battery and the two 100-kw. generators were overloaded.

In the summer of 1900 it was decided to establish a rotary converter sub-station near Twelfth Street and Grand Avenue, which would ultimately be supplied from a large alternating current central station to be built in the future. Orders were placed for four 200-kw., 125-volt, rotary converters, and not having at the time any available current of 6600-volts, 25-cycles, these were ordered with shafts long enough to carry a pulley so that two of them could be temporarily placed at the company's West Plant and run as belt driven generators, the current being stepped-up and transmitted to the new sub-station where it would be received by the other two rotary converters and fed into the Edison net work. While waiting for these machines summer was rapidly passing and the load increasing. During the fall, the National Street Railway Convention was held at Kansas City and the company purchased the 500-volt 600-kw. rotary converter, which was exhibited at the convention by the General Electric Company and which was therefore available for immediate use. Instead of installing the two 200-kw. 125-volt rotary converters at the West Plant as originally intended, the four rotaries were put in the sub-station at Grand Avenue, and the 500-volt 600-kw. rotary converter was placed in the packing plant of Armour & Co., where it was run as an inverted rotary converter, supplying current to the sub-station by means of step-up and step-down transformers. The four rotary converters at the sub-station were placed in operation in December, and for a time run without regulators or switchboard so badly were they needed to carry the load. How greatly current was needed can be judged from the fact that temporarily the incoming 6600-volt emergency line was controlled with three 220-volt switches. In the alternating current converter circuit, 500-ampere 200-volt switches fastened to 4 x 4 timbers were used for synchronizing. The voltage on the Edison system was regulated simply by manipulating the voltage slightly at the Armour packing plant. By the time three rotary converters were running, the Edison load had increased so that the inverted rotary converter at Armour's was overloaded.

In the mean time, to help out the arc system, four 150-light Brush arc dynamos for enclosed arc circuits were installed at the South plant. The arc circuits had been renewed, and the old lamps partly replaced by Adams-Bagnall series enclosed direct-current arc lamps. Part of the arc system was operated as before. To provide for the increasing load on the alternating-current system, a second-hand 100-kw. 1000-volt Slattery dynamo driven by a high speed engine, was installed at the South plant. Later a 125-kw. 2000-volt G. E. alternating current generator was installed at the West plant. All of the foregoing apparatus aided materially during the winter of 1900 to 1901, but it was soon realized that much greater provisions were necessary for the following winter.

During the winter plans were drawn for a large central station to be located on the Kaw River, but as no help could be expected from this source during the following winter, it was absolutely necessary that more temporary apparatus for the peak load of that winter be installed, and it was decided that the machinery purchased for temporary relief should be such that later on it could be used in connection with the new generating station.

The company owned an abandoned station on Santa Fe Street, where was located the first central station in the United States to use the T-H arc system. The plant had been idle for several years, and four small shell boilers, a small B. & W. boiler and a few high speed engines were still in the plant. These were all taken out, and the building temporarily repaired. Two new 500-h.p. B. & W. boilers which had been ordered for the new station were shipped at once and installed at this place. A 30 x 60 in. Hamilton Corliss and a 26 x 60 in. Brown Corliss were also installed, together with two 500-kw. phase changers. The 60-cycle, 2000-volt generator end of each machine was removed and a pulley placed on the shaft of the 500-kw. motors, which were driven as generators. This temporary plant was laid out in June and was in operation by the middle of December. The generators then supplied 25-cycle current to the four 200-kw., 125-volt rotary converters at the Grand Avenue sub-station, and also two additional rotary converters of the same capacity, which in the meantime had been placed in the Wall Street Edison generating plant. The inverted rotary converter at Armour's establishment was also used to help out with 6600-volt current during the heavy load.

During all these changes an underground system of distribution was being built to take care of the Edison three-wire network in the down-town district. While the service had not all been changed from overhead to underground lines by any means, much of the feeder copper had been installed, and some of these feeders were tapped to the overhead system.

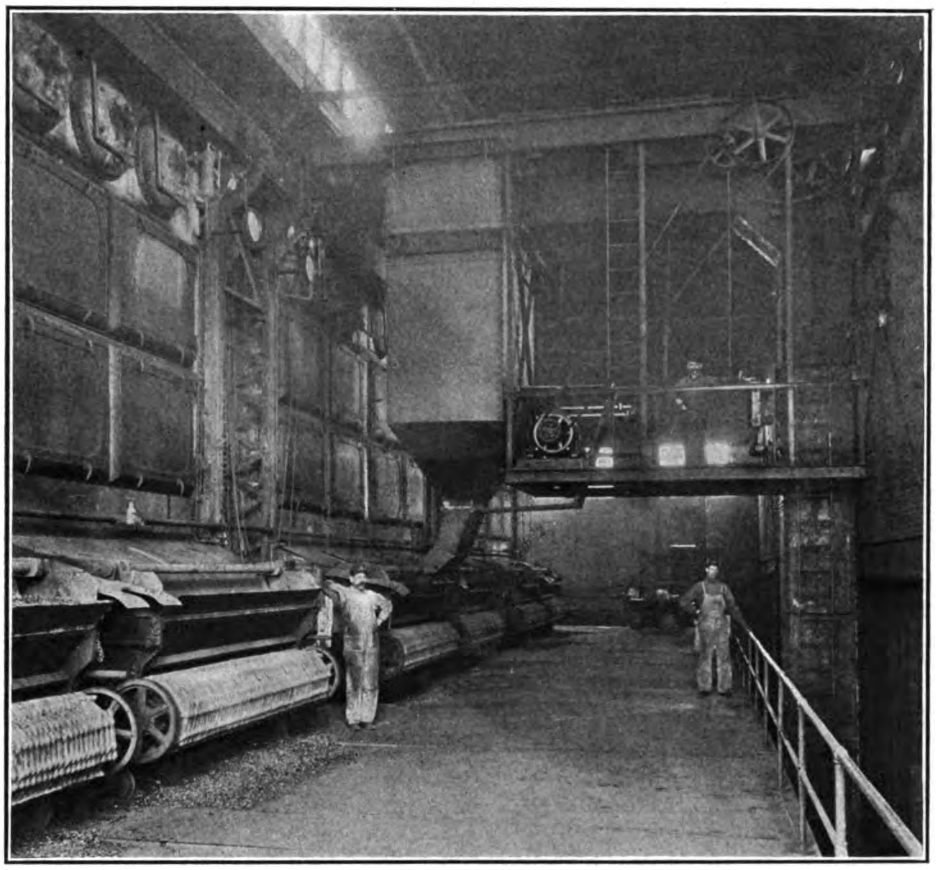

FIG. 3.—BOILER ROOM IN THE CENTRAL STATION.

The foundation for the new central station on the Kaw River was started during the summer of 1901, and finished the following spring, so that the skeleton was erected and the building put up during the following summer. In the meantime the alternating current load had increased so that it was necessary to install a second-hand 300-kw., 2000-volt, 133-cycle alternating current generator at the West plant, and a 100-kw., 1000-volt generator at the South plant. Two more 150-light Brush arc dynamos to operate enclosed arcs were installed at the South plant, and another at the West plant. By this time all of the open arcs had been changed to enclosed arcs.

In view of the fact that the street railway company, which was controlled by the same interests, contemplated erecting a very large central station on the Missouri River, which would ultimately supply considerable power to the electric lighting system, it was decided to simplify the new central station instead of erecting a very elaborate building.

On account of unreliable soil, the plant being located on what was once a river bottom, piles were driven for the building foundation and also for the engine and boiler foundations. The foundations were all built up of concrete and a concrete floor 24 inches thick was placed in the basement. The general dimensions of the building are 117 ft. x 172 ft. A brick fire wall divides it into engine and boiler rooms. The engine room is 60 ft. x 171 ft. The height under the roof trusses is 50 ft. The boiler room is 55 ft. x 171 ft. and its height under the roof trusses 30 ft. The floors of both rooms are of I beam and expanded metal and concrete construction. These floors are at present only finished around apparatus now installed. A 30-ton 3-motor Whiting Foundry and Equipment Company's crane spans the engine room, the rails for it being supported on the steel building columns.

The boiler plant consists of six B. & W. double deck water-tube boilers arranged in three batteries. They are rated at about 514 horse-power and generate steam at 175 pounds pressure. Each furnace is equipped with a Green traveling link grate, the grates being operated from a line shaft below the floor. Two 6-h.p. stoker engines are located in the basement between the ash pits. The ash pits have an approximate capacity of 350 cubic ft. Two steel stacks 9 ft. in diameter and 185 ft. are supported on I beams at the rear of the boilers. The flue gases are conveyed to them by a continuous steel breeching run in the rear of all boilers.

The coal storage bin is located outside the building directly below the street surface, and coal is shoveled from cars into this bin. The bottom slopes toward the basement with chutes every ten feet. A traveling Heil & Patton coal conveyor with a hopper capacity of 10 tons runs on tracks the length of the boiler room. This conveyor is run to any chute, and elevates the coal 48 ft. from the chutes into the hopper. When the hopper is filled, the apparatus is run along in front of the various furnaces, where the coal is discharged as needed. The hopper is suspended on scale beams so that an accurate record of the coal consumed can be kept. The coal conveyor is operated by a 10-h.p., 3-phase, 440-volt G. E. induction motor, which furnishes power both for moving the apparatus and for operating the coal conveyors. All the operations are controlled from a platform on the conveyor. For handling ashes a track on which is operated a steel dump car is installed in front of the ash hoppers. After the car is filled it is pushed to the north end of the building where an elevator raises it to a trestle, outside the building, where the ashes are dumped into empty coal cars and sold. If the demand for ashes is light, they are used to fill in quite an extensive area around the building.

The two engines installed are of the Allis-Chalmers vertical cross-compound condensing type 34 ins. and 70 ins. x 48 in. stroke guaranteed to develop 2250 horse-power with a consumption of 12½ lbs. dry steam per indicated horse-power hour, when running at 75 r.p.m. with 175 steam pressure, and 26 ins. vacuum. A special feature of the governor is a device used for controlling the speed of the engine from the switchboard while synchronizing the generators. It consists of a small motor operating a screw on which a ball weight travels; this weight being run to one side or to the other by the motor as desired when necessary to raise or lower the speed of the engine. A separate governor is also supplied to operate a special valve on the main steam line to shut down the engine in case of an unusual increase of speed. A gravity oiling system supplies the bearings while separate pumps feed oil to the cylinders. A Wheeler surface condenser containing 8000 sq. ft. cooling surface takes care of the exhaust steam. The condenser is guaranteed to take care of 80,000 lbs. of exhaust steam per hour. Circulating water for the condenser is supplied by Worthington centrifugal pumps owing to the dirt and rubbish in the water of Kaw River. Four of these are installed, in pairs, driven by 125-kw., 3-phase, 25-cycle synchronous motors. Each pump has a capacity of 6000 gallons of water per minute with a suction lift of 12 ft. and a head of about 8 ft. Under present conditions it is only necessary to run one pump, but the extra pumps were installed to take care of any future increase in engine capacity. Two Blake air pumps produce the vacuum for the foregoing apparatus. They are vertical twin pumps, each pump having two 12-in. steam cylinders, double-acting, and two 38-in. air cylinders, single acting, with 16-in. stroke. Only one of these pumps is used to take care of the present load. Two Worthington duplicate steam pumps draw water from the hot well to supply the heater, only one being in use at any one time. The pumps are regulated by floats in the heaters so that a constant level of water is maintained. A float in the hot well regulates the supply of city water to the well. Feed water is passed through a Webster heater and purifier having a capacity for heating 80,000 lbs. of water per hour from a temperature of 110 deg. to 190 deg. F. when supplied with 6000 lbs. exhaust steam per hour. The exhaust is supplied by the stoker engines and pumps. Two Worthington Admiralty pumps supply the boilers with feed water. They have a capacity of 450 gallons per minute against 200 lbs. pressure.

All piping is extra heavy, as are also all fittings and valves. A Cochran vacuum oil separater is placed between the header and condenser, the oil being trapped off by two traps which work automatically. A special duplex pump is provided to take water from the river for circulation through the engine guides and bearings and to supply water for washing boilers and other purposes around the station.

Arrangements have also been made so that water direct from the river can be used to supply the boilers. In such a case the water is forced through a Ross filter. A pump pit is located in the basement to take care of all drainage. A Yeoman's motor driven bilge pump, operated by a float in the sump pit, takes care of all the drainage.

The generators are rotating field, 1500-kw., 6600-volt, 25-cycle machines, made by the General Electric Company and direct connected to the engines. The guaranteed efficiency of these machines is 94.5 at full load; 93.5 at ¾ load; and 91.5 at ½ load. The motor-driven exciter is of the same make. The motor is a 215-h.p., 3-phase induction motor operating at 440 volts. The exciter is a 150-kw., 125-volt, 6-pole generator. Three 75-kw., 25-cycle oil transformers reduce the voltage from 6600 to 440 for supplying the motors. An emergency steam-driven exciter set is also provided consisting of old material taken from the Edison station. This set is used very seldom; only in case of a complete shut-down or to give an opportunity to clean the motor-driven exciter.

To supply the 500-volt motor circuit the demands on which were still quite extensive the rotary converter which had been used at the Armour packing plant to supply 6600-volt, 25-cycle, alternating current, was taken out and run as a regular rotary converter at this station. This is an eight-pole, 600-kw., 600-volt compound wound machine with a full load efficiency of 93.5 per cent; ¾ load, 92.5 per cent; and ½ load, 90 per cent. The 6600-volt current to operate this is stepped down through three 250-kw. air blast transformers to 380 volts. The efficiency of the transformers at full load is 97.5 per cent and at half load 96 per cent.

To supply the alternating current incandescent service, two 500-kw. motor generators were installed. Each motor is a 500-kw., 8-pole, 660-volt, 25-cycle machine running at 375 r.p.m. The motors have stationary armatures and are run as three-phase synchronous motors. The generators connected to them are 20-pole, 2300-volt, 62½-cycle, two-phase machines. The motors of these sets were first used as generators in the temporary Santa Fe plant. As the new central station is conveniently located for supplying the arc lights for Kansas City, Kan., two motor-driven arc sets were also installed. Each motor is a 6-pole, 180-kw., 6600-volt, 3-phase synchronous machine equipped with flexible couplings on both ends for direct connection to Brush arc generators. These motors as well as the motors for the phase-changers and the pump motors are supplied with starting compensators. Each Brush arc gen-

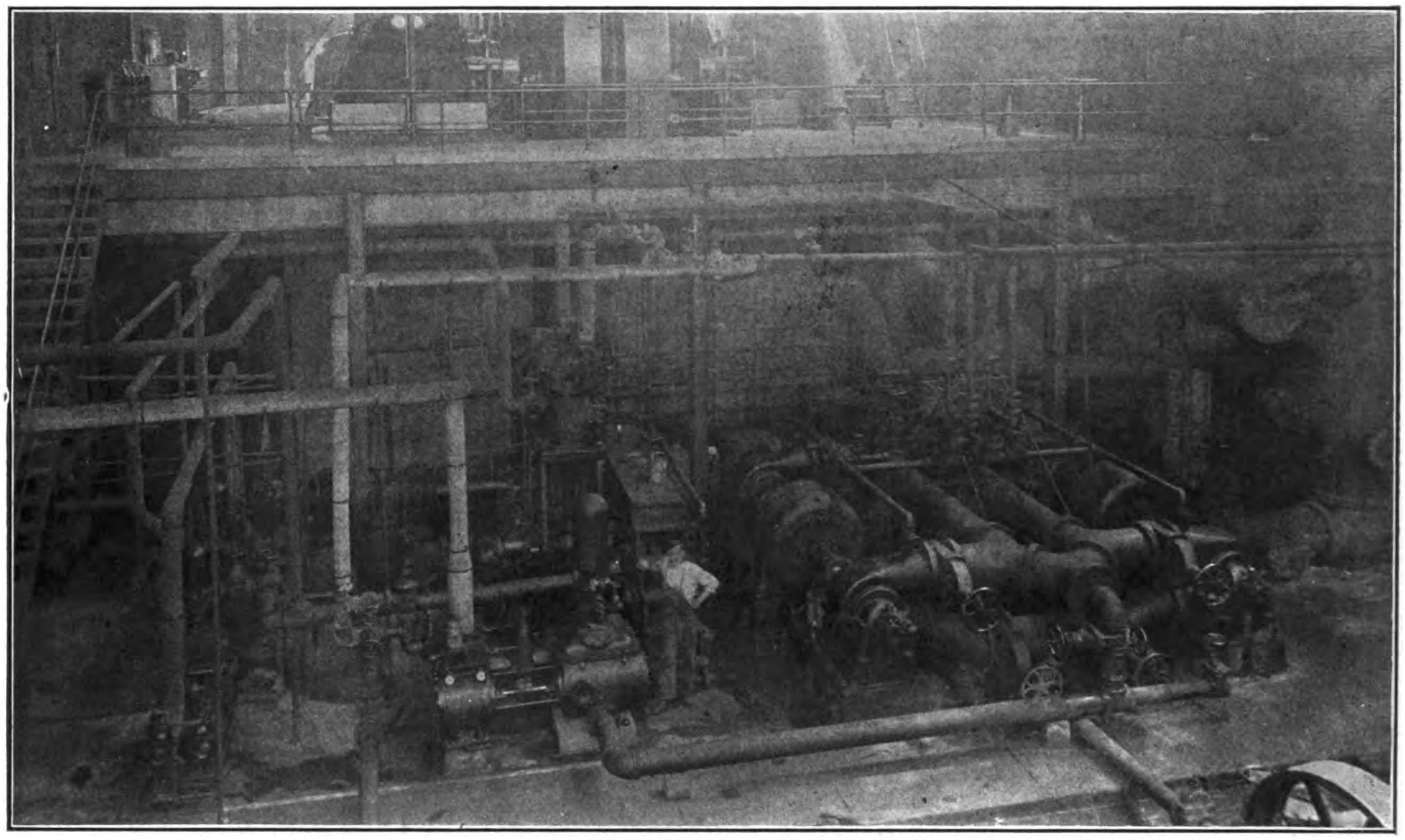
FIG. 4.—CONDENSER AND FEED-WATER EQUIPMENT.

erator is a four-circuit machine and has a capacity of 150 enclosed arc lamps. The current is 6.6 amperes and the machines are equipped with oil regulators. The efficiency of the arc generator at full load is 88 per cent and at half load 79 per cent. The synchronous motors and the arc generators that they drive are mounted on heavy wooden bases. A motor-driven air compressor, such as is used on street cars, was installed in this station for cleaning armatures.

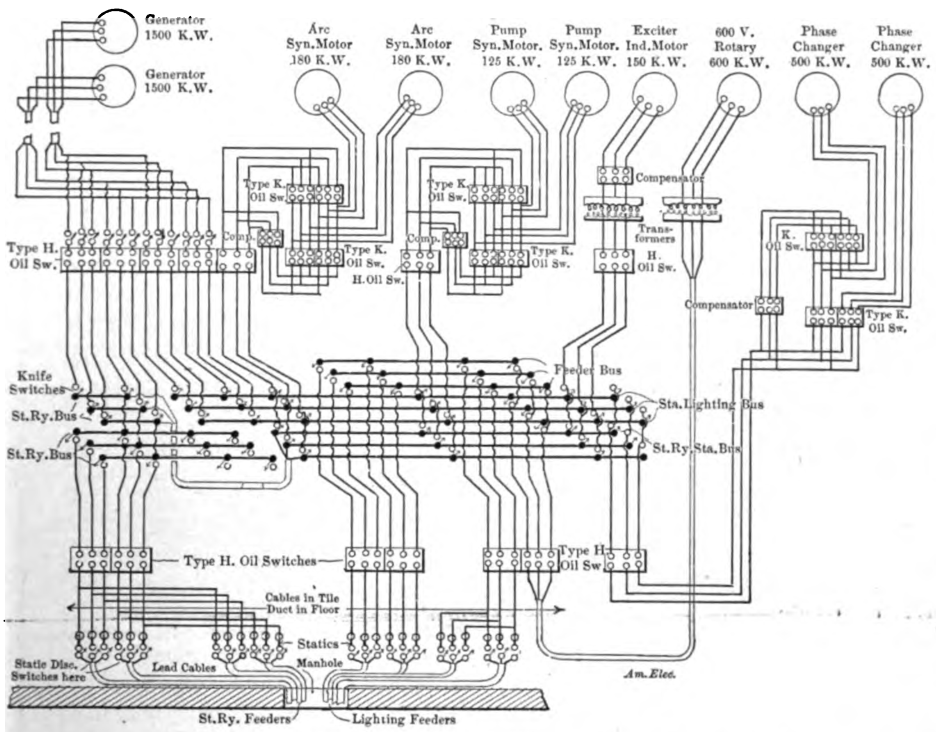
Generator 1500 K.W.
Generator 1500 K.W.
Arc Syn.Motor 180 K.W.
Arc Syn.Motor 180 K.W.
Pump Syn.Motor. 125 K.W.
Pump Syn.Motor. 125 K.W.
Exciter Ind.Motor 150 K.W.
600 V. Rotary 600 K.W.
Phase Changer 500 K.W.
Phase Changer 500 K.W.
Type K. Oil Sw.
Type K. Oil Sw.
Compensator
Type H. Oil Sw.
Comp.
Type K. Oil Sw.
H. Oil Sw.
Comp.
Type K. Oil Sw.
Trans-formers
H. Oil Sw.
K. Oil Sw.
Compensator
Type K. Oil Sw.
Feeder Bus
Knife Switches
St.Ry.Bus
St.Ry.Bus
Sta.Lighting Bus
St.Ry.Sta.Bus
Type H. Oil Switches
Type H. Oil Sw.
Cables in Tile Duct in Floor
Statics
Static Disc. Switches here
Lead Cables
Manhole
Am.Elec.
St.Ry. Feeders
Lighting Feeders

FIG. 5.—DIAGRAM OF HIGH TENSION SWITCHBOARD CONNECTIONS.

The switchboard is of standard blue Vermont marble, mounted on angle-irons. There are three feeder panels, supplying 6600-volt current to rotary converters of the Edison system, on each of which panels are mounted three alternating current ammeters, one time-limit relay for tripping the oil switch, one controlling switch, and two indicating lamps for General Electric, type H oil switches. The totalizing panel for these three feeders is supplied with one balanced, three-phase, indicating wattmeter, and one balanced, three-phase, Thomson recording wattmeter. The panel controlling the induction motor for the exciter has one 150-kw. balanced, three-phase recording wattmeter, one ammeter, one balanced, three-phase indicating wattmeter, one lever for operating the compensator, one controlling switch for operating automatic, type H, oil switch with two indicating lamps, and one time-limit relay. The motor panels for the centrifugal pump motors have a power factor indicator, an ammeter, a field switch, two levers for operating form K. oil switches, and also a panel containing a lever for the starting compensator. Only one compensator is used for both pumps. One panel has on it one time-limit relay, one controlling switch and indicating lamp for a type H oil switch; the other has a balanced three-phase recording wattmeter. There are two exciter panels. The one for the motor-driven exciter has an ammeter, a voltmeter, a 600-volt, 2000-ampere, single-pole toggle-brush, carbon-brake switch, and one five-point, 100-ampere rheostat switch. This latter is not used at present. The panel for the engine driven exciter contains the same instruments as the other, but without the five-point switch. The negative bus is on the switchboard and the positive bus below the floor.

The two generator panels are each supplied with the following: one power-factor indicator, one alternating-current ammeter, one voltmeter, one field switch, one four-point synchronizing receptacle, two type H oil controlling switches, and four indicating lamps. There are also one double-throw switch, to control the engine governor for synchronizing and one pedestal for the rheostat. The panels for the 500-kw., phase-changer motors have a power-factor indicator, an ammeter, a field switch, and two operating handles for form K oil switches. The totalizing panel for these two motor panels contains one balanced three-phase indicating wattmeter, one balanced recording wattmeter, two controlling switches, and four indicating lamps for automatic oil switches. There is also a lever for operating the compensator. For the two motors driving the arc generators, two panels are equipped with the following: one power-factor indicator, an ammeter, a field switch, and two levers for operating type K oil switches. These motors have a totalizing panel which has a balanced three-phase indicating wattmeter, and recording wattmeter, two controlling switches, a time-limit relay, and a compensator lever.

For 2200-volt two-phase distribution the two generator panels of the motor generator each have two indicating wattmeters, two ammeters, two voltmeters, and one operating handle for a four-pole non-automatic oil switch. The two alternating current 60-cycle feeder panels have two single-phase indicating wattmeters, two ammeters, two voltmeters, one two-phase unbalanced recording wattmeter, and two double-pole, single-throw, hand-operated oil switches. For the arc circuits, four panels are installed, each of which accommodates four generator circuits, and four line circuits, together with transfer busses, and voltmeter busses. In addition to the foregoing apparatus, two 6600-volt Lincoln synchronizers for synchronizing the generators have been installed, and also one 220-volt Lincoln synchronizer for motor-generator phase changers. There are also static dischargers, and connecting switches for the feeders in the bus compartments.

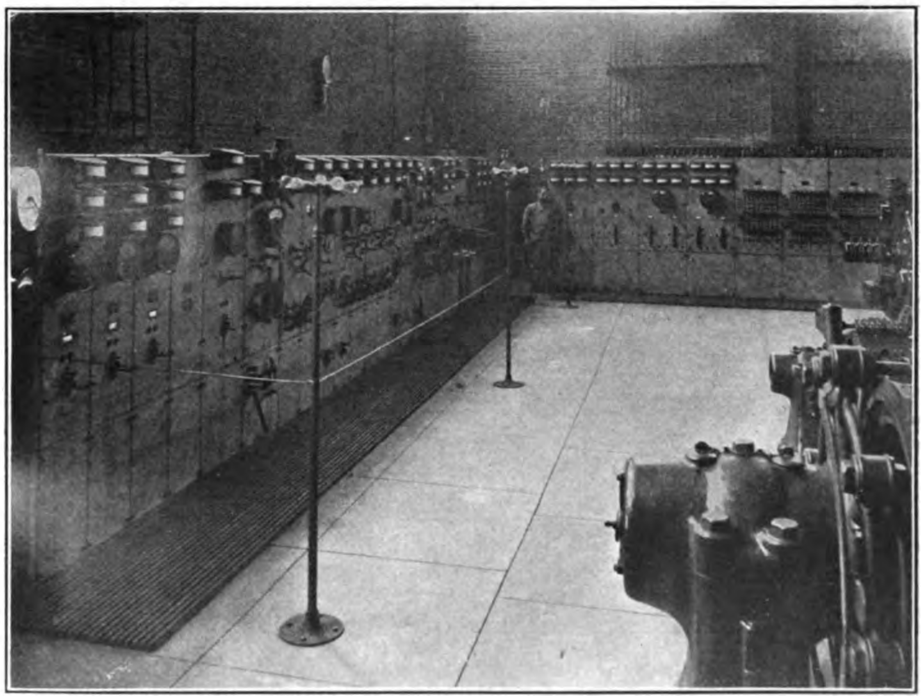

FIG. 6.—MAIN AND ARC SWITCHBOARDS.

The original layout of this plant included provision to supply the street railway company, as it was also short of power. For this purpose special bus-bars for 6600-volt current were provided. All of the high tension bus-bars and leads are confined to the basement, so that the only current that comes to the main switchboards is 125-volt direct current. Of course, the 2200-volt, 60-cycle alternating current, as well as the arc circuits, come to switchboards especially installed for them.

Starting from the two 1500-kw. generators, two cables lead to a sort of an auxiliary double bus-bar compartment, so arranged that either generator may be used to supply either the street railway or the lighting load. One pair of bus-bars is connected to No. 1 generator and one to No. 2 generator. From these bus-bars there are four sets of leads; two sets, one from each generator, connect through switches and "type H" oil switches to the street railway bus-bars, and two by the same means to the lighting bus-bars. The generator bus-bars of the street railway are connected to bus-bars which were laid out to supply four feeders, but only two oil switches were installed for the railway feeders; therefore, the provision for two extra feeders was not used. Later on, two more feeders were brought in, but as they were temporary, they were connected to the leads from the existing oil switches. The short railway generator bus-bars are connected to the railway station bus-bars by means of a cable. These railway station bus-bars were arranged so that later on, when the railway company had its power house in operation, the lighting company could transfer some of its load to the railway power house, and also, when one of the lighting generators was being used to help the railway, a part of the lighting load could be supplied from the same generator. Only the pump motors and arc dynamo motors are run from these bus-bars at such times on account of the variations in railway voltage.

The station lighting bus-bars are so arranged that all auxiliary apparatus can be run from them, while the feeders that supply the rotary converters used on the Edison system down town have their own bus-bars, which are connected through switches to the main station bus-bars.

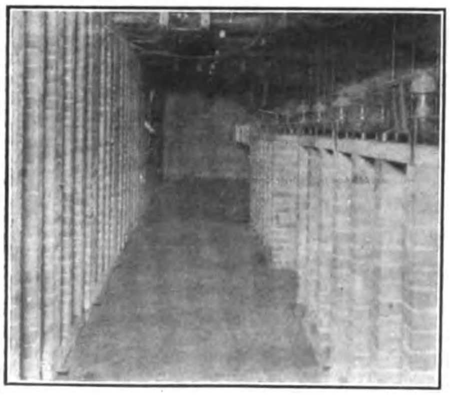

FIG. 7.—OIL SWITCH AND BUS-BAR COMPARTMENTS IN BASEMENT.

The motors for the 500-kw. phase changers are connected as follows: starting at the main bus-bars two-way switches are arranged so that these motors can be run from either the railway or the lighting bus-bars; a "type H" motor-operated oil switch, controlled by an overload relay, controls both sets of motors, but each motor circuit is controlled after this by a set of "type K" non-automatic switches; one switch cuts in the compensator for starting and when the motor is up to speed the second switch cuts in the motor direct. Only one compensator is used for both motors.

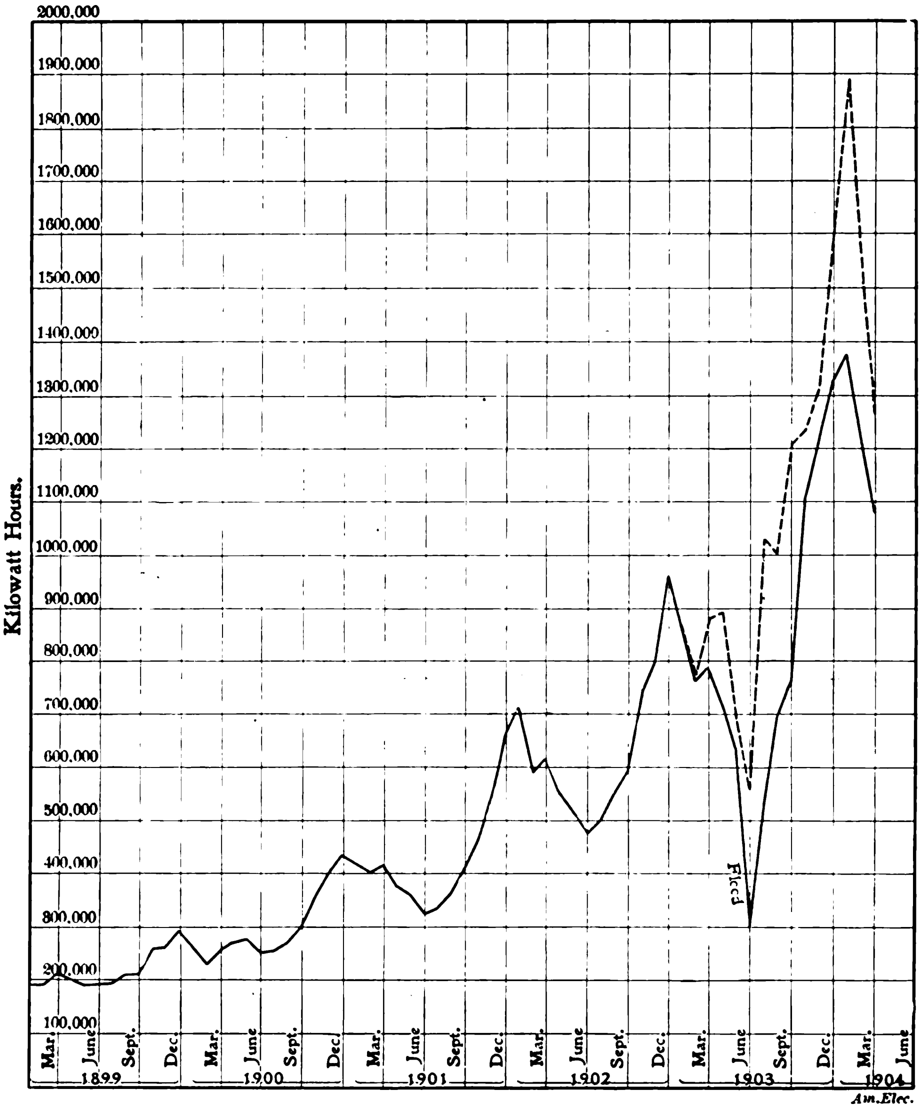

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FIG. 8.—CURVE SHOWING INCREASE IN OUTPUT FOR DIFFERENT YEARS.

The 600-kw., 600-volt rotary converter for the power circuit also has a "type H" motor-operated oil switch, with an overload relay, but has no starting compensator, as this machine can be started from the 550-volt railway circuit on the direct-current side and when in synchronism, the oil switch is closed. A Lincoln synchronizer is used for synchronizing.

The two 125-kw. synchronous motors for the circulating pumps and the two 180-kw. synchronous motors for the arc-light dynamos are connected up like the 500-kw. phase-changer motors, only one compensator being used for each pair.

All potential and current transformers for indicating and recording instruments are placed in the basement as close to their respective leads as possible, to avoid as much as can be the running of high tension wires promiscuously. The three oil transformers for the exciter motor, as well as the three air blast transformers for the 500-volt rotary converter are also located in the basement. Current for the three-phase, 25-cycle, 440-volt coal conveyor motor is taken from the exciter transformers; these same transformers also furnish current for the ash elevator motor.

The central station described furnishes current for all the series arc lighting in the western part of town and in the immediate vicinity. All of the 60-cycle alternating current for incandescent lighting is furnished from this station at present. The 500-volt power circuit is also furnished from here. The 6600-volt, 25-cycle current is carried to up-town sub-stations by means of three No. 0 and one No. 00 cables. An emergency line running overhead of No. 00 wire was also installed, as at the start some trouble was experienced with cables.

At the sub-station, located at Sixth and Wall Streets, at present two rotary transformers of 200-kw. capacity are operated to supply the Edison system, and a few bi-polar Edison machines are run by steam. This steam plant will be discarded in about a month, as at present a 750-kw. 220-volt rotary is being installed, and later on the four 200-kw. rotaries at the Thirteenth Street and Grand Avenue sub-station will also be installed at this station. The present station, located at Thirteenth Street and Grand Avenue, contains four 200-kw. rotaries, to supply the Edison system; also a motor driven arc set, the same as used at the Central station. This sub-station is to be discarded and a permanent sub-station is to be located at Fifteenth Street and Grand Avenue, where the street railway company has a sub-station in the same building. At this sub-station there is being installed at present a 750-kw., 220-volt rotary converter to be used on the Edison system. There will also be a motor driven arc set installed at this sub-station. At Thirty-first and Holmes Streets, where the street railway company has a sub-station, there will also be installed a motor driven arc set. At present there is installed at this station for the lighting company three 6600 to 2200-volt, 25-cycle static transformers. These are used for furnishing three-phase, 25-cycle current for motor power in that neighborhood, especially for elevator service in apartment houses. A sub-station is also to be installed by the street railway company at Twelfth and Cleveland Streets, where the lighting company will later on install two motor driven arc sets and another phase changer to supply the eastern territory. The present South plant is to be discarded. All of the arc generators there at present are to be coupled in pairs to a motor and installed in the above named stations.

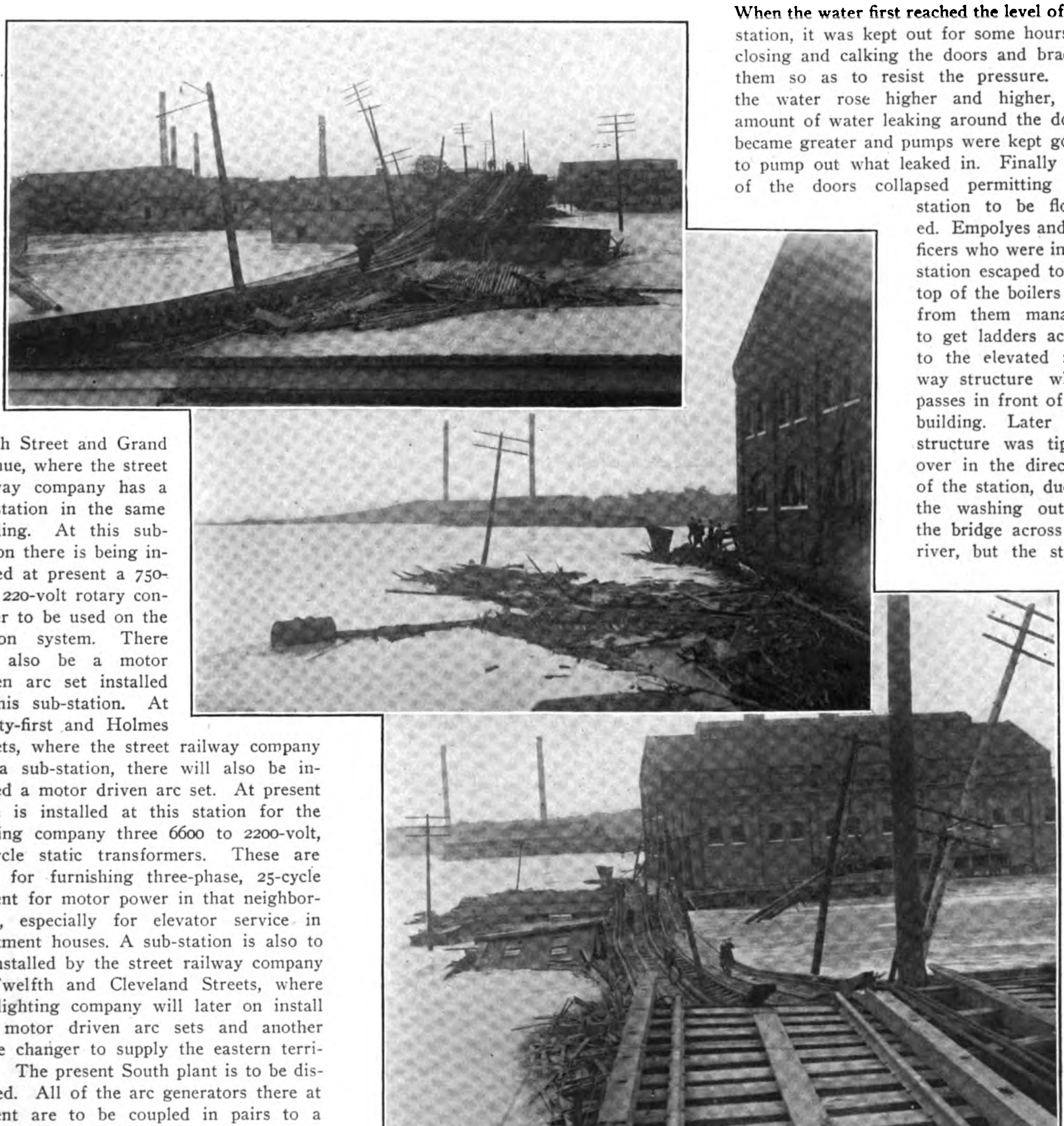

FIG. 9.—VIEWS SHOWING RESULTS OF FLOOD.

As the company has had so many different types of stations under its control, all in the same city and as nearly as possible under similar conditions as to wages, price and quality of coal, and efficiency of management, it has had an unusual opportunity to determine the relative economy of the apparatus in these different stations. The coal burned is Cherokee Kansas slack, containing about 17 per cent of ash and having a calorific value of about 11,000 B. T. U. The new Central station, when running condensing, obtains 225 watts per pound of coal. When running non-condensing, the output is 165 watts per pound of coal. This is a compound condensing station with 1500 kw. units, water-tube boilers, and link grate stokers. The "South plant" gives 127.5 watts per pound of coal. The "Santa Fe" station gives 142.9 watts per pound of coal. The Edison station on Wall Street gives 45.1 watts per pound of coal. The Central station is operated by twenty men, the "South plant" by fourteen men, and the Edison station by eleven men. When open arc lamps were used entirely, fourteen trimmers were required. There are now 3300 enclosed arcs and only six trimmers are employed. All of these figures are interesting because they are the results of actual work and not theoretical assumptions.

THE FLOOD.

On May 30, 1903, the last piece of apparatus had been installed at the Central station and the next morning the river rose very suddenly. The station was flooded for several days, and the water reached just above the main bearings, of the alternators. When the water first reached the level of the station, it was kept out for some hours by closing and calking the doors and bracing them so as to resist the pressure. As the water rose higher and higher, the amount of water leaking around the doors became greater and pumps were kept going to pump out what leaked in. Finally one of the doors collapsed permitting the station to be flooded. Empolyes and officers who were in the station escaped to the top of the boilers and from them managed to get ladders across to the elevated railway structure which passes in front of the building. Later this structure was tipped over in the direction of the station, due to the washing out of the bridge across the river, but the structure was still in such condition that employes could use it as a means of entrance to and exit from the station.

The height of the water above the lowest basement floor was 28 ft., which brought it just above the main bearings of the engines, and just below the top row of instruments on the switchboard, the switchboard being located on the main floor of the station.

When the water subsided, a most discouraging sight was presented to the company's engineers. Not only was every piece of electrical machinery in the station soaked with water, but upon everything there was a thick deposit of mud. The high-tension bus-bar compartments, which are below the main floor, were of course flooded, and filled with this same slimy mud. It was not thick enough to shovel and yet too thick to pump. The only way in which it could be handled was to bale it out. One can imagine the situation. Over half of the big main generators under water and every other piece of electrical apparatus, every exciter, motor generator, potential transformer, high-tension cable, and high-tension bus-bar compartment, full of slime, with a liberal supply of cinders, timber, stockyard refuse, and other choice débris thrown in. As fast as the water receded the company went to work to get its demoralized service into shape again. The mud was scraped and washed off the apparatus as well as it could be, and when the water finally left the station ~~the hose was turned~~ on to the armatures and as much mud as possible dislodged in that way. Then the armatures were turned over and more mud dislodged. After washing out all coils and picking the cinders out of the small cracks, salamanders were started to dry them out. When some of the moisture had been driven off in this way, current was secured from the Wall Street Edison station downtown, and conducted over three miles of trolley line to aid in drying out the generators.

Nine days after the floor receded, the first 1500-kw., 6600-volt generator to be dried out measured 60,000 ohms insulation resistance. Although advised to the contrary, the management decided to start this generator, on account of the urgent need for service, and operated it at an overload within a short time. After operating 36 hours, two coils burned out. The experience with the second generator was similar to that of the first. The two coils lost in both cases were at the high-water mark, and it is thought that they were damaged by chemicals which floated down from chemical works up the river. The balance of the coils were uninjured, and have been in continuous service ever since. The small armatures were treated like the large ones. Steam coils, salamanders, and compressed air, aided by pieces of flat wire to pick out the cinders, were used in the task. The cores and coils of the static transformers were taken out of the cases, washed, and dried in the sun, and the cases also washed out.

The most annoying trouble of all was the leakage of water into the high-tension lead-covered cables at the pot heads. The pot-heads where the conductors leave the cables to connect to the bus-bars were never intended to stand the water pressure they were subjected to, and consequently water entered the cables and worked back distances of 15 and 20 feet, or more. There were over 30 6600-volt pot-heads, and 100 pot-heads altogether in the station.

Current was on the lines eleven days after the flood. The only losses of electrical apparatus which could be traced directly to the flood were some small potential transformers which probably did not receive a proper amount of care in the drying out process, owing to more important things being dried out at the same time. The bearings, which of course were filled with Kaw River mud, were first flushed out with water and then with kerosene oil. No trouble was experienced with hot boxes. The incident shows what a wonderful amount of abuse modern electrical apparatus can withstand and still be brought back into service.

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A REVOLUTION IN PRIME MOVERS.

BY DR. LOUIS BELL.

Just at the present moment the whole subject of prime movers for central stations is in a condition of plasticity that leaves its probable future in great uncertainty. One really hesitates in expressing more than a mere tentative opinion, for the present data ~~are entirely insufficient~~. ~~The steam turbine~~ has now been a long time in evolution and has already been brought into a form that is highly satisfactory. It is not necessary or pertinent here to discuss the details of the theory of steam turbines, still less the principle of the internal combustion engine that already looms large in view. The bare facts in the case furnish quite sufficient food for reflection.

At the present time steam turbines of half a dozen different forms are being actively exploited. They represent various modifications of the turbine idea and vary in construction over even a wider range than do water turbines, but in much the same sort of way. They possess in common the characteristic of very high rotative and peripheral speed, rendered necessary by the very great spouting velocity of the tenuous fluid by which they are operated. As is evident on a moment's reflection, this high velocity is the source of their strength and their weakness. It results immediately in a very large output of power from a relatively small machine, and hence in a prime mover of moderate cost and great compactness. The form of construction likewise results in extraordinarily low frictional losses, especially in those turbines which are worked on a vertical shaft, and as a necessary consequence the mechanical efficiency is high at all loads and relatively very high at low loads.

The dynamos connected to turbines are likewise possessed of high speed, which is by far the cheapest way to get electromotive force; so that taken as a whole, a turbo-generator is a cheap, efficient and compact machine, as everybody now realizes.

On the other hand, the very high speed of steam turbines means great extra precautions in both workmanship and material in order to insure safety, and makes the turbine extremely inconvenient for direct coupling to direct-current machinery. There have been a good many direct-current turbo-generators produced abroad, mostly in small sizes, but those who have looked into their operation are seldom enthusiastic about their performance in practical every-day work.

Hence turbines are at least temporarily barred from the very field in which their good qualities would be of the greatest value, that is, the small central station railway plant or isolated lighting plant. In such places the usefulness of the turbine is limited to those which dispense alternating current—at present only a rather small fraction of the whole. If direct current is the product, by the time one has added in the cost of converters and discounted their losses, the combination fails to show high efficiency. The future of the turbine is therefore linked with the future of alternating currents. Recent developments in alternating-current motors, especially for railway use, will tend to remove this disability and there is always a chance for the appearance of a direct-current dynamo suited to extreme rotative speeds.

For the present, however, the large field of steam turbines is in the large lighting and power stations, where they are already in extensive use. For these situations their ~~good light-load efficiency~~ and their low cost are very strong recommendations. Personally, the writer does not attach great importance to the saving in space, except in occasional instances, since turbines need just as much boiler capacity as reciprocating engines of similar output, and the problems involved in the design of the boiler room and piping systems are apt to render it difficult to utilize the full saving of space so readily obtained upon paper.

As to the actual relative efficiencies of turbines and engines in steam required per kilowatt-hour of output, the figures thus far obtained leave the issue in doubt. Worked at the same initial steam pressure, degree of superheat and vacuum, the compound condensing engine seems to hold its own well at full load with the turbine, although the conditions are so seldom the same that comparisons are far from easy. The turbine as at present developed requires more vacuum than the engine, and has rather the worst of the pressure question, since extra pressure aggravates the speed difficulty. At low loads, most tests give a considerable advantage to the turbine, although comparison with engines especially planned for economy at moderate loads show the two machines nearly upon a parity.

The best results with triple expansion engines, however, have not been nearly duplicated by the performance of turbines. The turbine undoubtedly will be considerably improved, but it will also goad the engine builder to the attainment of economy higher than has hitherto been reached. At present the two machines are neck and neck, as it were, in the race for minimum cost of power production, but both have to reckon with a very dangerous competitor in the internal-combustion gas engine. This prime mover, familiar in small sizes, starts with the advantage of a thermo-dynamic efficiency far in excess of anything which there is yet reason to expect from steam engines of any sort. Roughly, it transforms into work twice as great a proportion of the heat supplied as does any other form of heat engine; its efficiency is 20 to 30 per cent instead of 7 to 12 per cent as in steam engines of similar output. What is more, it is relatively in a far earlier stage of development. It loses in its exhaust, probably without sufficient cause, a greater proportion of the heat supplied than the best steam engine transforms into work. The preventable heat losses outside of the exhaust are probably at least as large. The recovery of this lost energy is the task now before the gas engine designer. The engines heretofore built have been heavy and bulky, but the very extensive use of the type in automobiles has already produced great improvements in construction and the resulting competition has reduced prices. Likewise, the need of continuous rotary effort in automobiles has produced engines with carefully balanced multiple cylinders, and worked with high-speed compression, so that the old gas engines with irregular speed and enormous friction losses bear about the same relation to recent machines that the "atmospheric" steam engine of Newcomen's day bears to the engines of a torpedo-boat destroyer.

There is no reason why internal explosion engines of large power should be abnormally heavy or should present unreasonable friction losses. The cylinder pressures involved are not excessive, and the moving parts need not be either very massive or very complicated. One difficulty which is peculiar to the gas engine is the very high initial temperature of the working fluid, a necessary concomitant of very high efficiency. This renders it more difficult to deal with the friction and lubrication problems than in the steam engine, but here again the automobile comes to the rescue. For automobile use the engines must be capable of continuous operation with little attention and at high rotative speeds. Therefore the friction must be kept down within moderate limits. But the bigger the engine, the relatively less is the friction difficulty, and what would be fairly successful avoidance of friction in an automobile would be highly successful in a large engine. And the friction difficulty is greatly exaggerated by the steam contingent anyhow. Even in engines of very moderate size the brake horse-power can be kept up to 80 or 85 per cent of the indicated horse-power, and in large engines the friction is not much in excess of that of a compound steam engine with its accessories counted in.

The outlook at the present seems to the writer to show probable great improvements in the internal-combustion engine within a very few years, greater than can be hoped for in any prime mover driven by steam. Even now the great gas engines used abroad, and just now being introduced into this country, are probably capable, under reasonably favorable conditions, of giving power more cheaply, all things considered, than any existing steam engine. We are not used to the idea in this country and balk at using a gas producer instead of the good old-fashioned boiler, but the lowering of cost is a powerful argument, and whenever the gas engine can show clear gains over the steam engine in total cost of power it must forge to the front. It does not seem likely that so revolutionary a change will come at once in any event, for large gas engines will have to be in use for some years before the cost of upkeep becomes a certain quantity. But the writer is strongly of the opinion that the internal-combustion engine will take a very important place in power station practice in the not distant future. It lends itself very readily, too, to the kind of sub-station work that is now common. Certainly within a moderate radius gas can be distributed to sub-stations with gas engines in large units probably more economically than current can be generated, transmitted and converted. There is also more or less discussion regarding internal-combustion turbines. The outlook in this direction is at present less hopeful than that for the reciprocating form, and whatever it may be, it is with the reciprocating engine that we have now to deal. The St. Louis Exposition is likely to be an eye-opener to those interested in prime movers, and the big gas engine exhibit is one that will be worth very careful study.

It is a curious chance that the steam turbine should have come upon the field just as the internal-combustion engine develops as a serious competitor, but similar things have happened before. As between the turbine and the ordinary steam engine, the battle must be fought out on the present basis. Both must keep an eye out for a very dangerous competitor in the gas engine, which is developing very rapidly. Within a year or two it will force its way into central station practice, not as a freak but as a standard apparatus. From that point out, it is anybody's race in the struggle for supremacy, with certain intrinsic advantages in favor of the newest comer.

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FURNACE FITTINGS FOR STEAM BOILERS.

BY R. T. STROHM.

The object of the steam boiler furnace is to furnish a properly arranged chamber in which the combustion of the fuel may take place. In order that it may accomplish this purpose satisfactorily it must provide a support for the fuel during its combustion and it must confine the gaseous products of combustion and direct them against the heating surfaces of the boiler. The furnace fittings then resolve themselves into three classes. First, the materials composing the furnace itself; second, grates for the support of the fuel; third, appliances for aiding the process of combustion.

In order to produce efficient and economical combustion, the furnace must be refractory, since it must not only withstand continued high temperatures, but must maintain them, in order that the ignition of the fuel may be carried on successfully. The combination of carbon and oxygen occurs only at temperatures above 800° F. As a result, it becomes necessary to build the furnace of some material which shall aid, as far as possible, in maintaining a high furnace temperature. Further than this, the material must be fairly durable, not high in first cost, and easily, cheaply and quickly repaired in case of accident or natural deterioration.

The material most largely used for furnace construction is fire brick. The bricks are somewhat larger than the ordinary red brick, but they should be laid more closely. That is, the thickness of the mortar should not be as great as in the case of the ordinary red brick. Again, the mortar used must also possess the refractory qualities of the brick. So it is customary in a large number of cases to use fire clay in laying up furnace walls. The bricks themselves are of fire clay, but there is this marked difference. They have been thoroughly baked and burned, whereas the fire clay is yet raw. The consequence is that when the furnace walls are subjected to a high temperature, the fire clay bakes into the same state as the bricks, shrinking in so doing. For it is a peculiarity of this material that it shrinks under the effects of high temperatures. Unless the wall is very carefully built, this shrinking may so loosen the bricks as to cause them to tumble down under the ordinary conditions of service. The binding value of fire clay is also low, so that it has little effect in cementing the courses together. Where the wall is laid in courses of stretchers with only an occasional course of headers, it will easily disintegrate, and a few light blows from the firing tools, either by accident or in knocking clinker from the walls, may result in the dropping out of bricks until the lining is practically ruined.

To obviate this difficulty, a mortar composed of fire clay, pulverized fire brick and lime has been suggested, which will not shrink to the same extent as the fire clay alone. In addition to this, those portions of the walls immediately enclosing the furnace are laid in courses of headers, giving a much stronger wall and making it better able to resist hard firing and the careless use of fire tools. It is not good practice to allow broken ends of fire bricks to face the furnace. The hard baked surfaces should be in contact with the flames and the hot gases, all cut surfaces being turned into the wall.

The bridge, which directs the gases upward into close contact with the shell, must also be capped with fire brick. In this case, the bricks should be laid on edge, so as to reduce the liability of damage when cleaning or drawing the fire. There are two forms of bridge wall in use. One has a concave top, corresponding to the curvature of the shell, and the other has a level top. The latter is preferable, since it is more easily constructed and less easily injured, and it is the form commonly used. The front of the bridge wall is usually beveled so as to facilitate firing operations.

Grates as used in steam boiler practice may be divided into three general classes, namely, stationary, rocking and traveling grates. The first class includes all grates formed by fixed, rigid bars. The second class includes those grates in which the bars may be given an oscillating or rotary motion, either by hand or by some form of motor. The last class comprises those types in which the entire grate surface moves uniformly in one direction. However, since mechanically operated rocking grates and traveling grates come more directly under the head of mechanical stokers, which may be regarded as a distinct subject in itself, only the stationary grate and the hand-moved rocking grate will be considered in this article.

If it were the sole purpose of the grate to support the fuel, it might be a heavy pier of masonry covered with fire brick. But it must also allow the passage of air through the fuel bed, which necessitates a perforated structure. This is accomplished in various ways. Doubtless one of the simplest and most common forms of grate is that illustrated by Fig. 1. It is nothing more or less than a narrow bar of cast iron, having lugs projecting laterally at the ends and at the middle. The grate is built up by laying a number of these bars side by side. The lugs thus separate the individual bars sufficiently to form the air spaces.

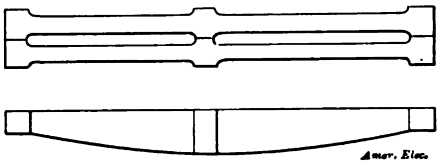


FIG. 1.

It is evident that to obtain the best results the grate should be so proportioned as to give the maximum amount of air space and at the same time prevent the fuel from dropping through. This means that the grate must be selected in accordance with the size and nature of the fuel to be used. The width of the air space is limited only by the size of the coal. The thickness of the metal is limited by the ease of casting on the one hand and the requisite strength of bar on the other hand. The former varies from ¼ inch to 1 inch for the several grades of coal used in steam making, while the latter seldom, if ever, exceeds ½ inch.

FIG. 2.

Grate bars are commonly made of cast iron, the reasons for which are not hard to find. In the first place, the bars are subjected to an intense heat, which demands that they be made of some material which will not easily soften. They must not be affected to any great extent by the impurities in the coal. They should be of a cheap material, and should not be expensive to manufacture. Cast iron meets these requirements better than any other material, and in consequence is the most largely used.

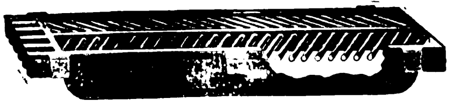


FIG. 3.

Another very common form of grate bar is that shown in Fig. 2, and known as the herringbone pattern. It consists of a large number of short webs between two parallel bars. These shorter webs are made V-shaped so as to provide for their expansion and contraction without damage. The advantage claimed for this type of bar is that it possesses more than 50 per cent. of air space and yet gives a strong, durable grate. It will be noticed that the webs are thinner at the bottom than at the top. The purpose of this construction is to prevent clogging of the grates by ashes or clinker. If a piece of refuse once gets through the space at the surface of the grate, it will not stick anywhere else, since the air space grows gradually wider. A slight variant of this style of grate bar is illustrated in Fig. 3, in which the central web is replaced by a number of short wrought iron bars. The bar shown in Fig. 4 does not differ materially from that shown in Fig. 3, but the pattern for it is easier to construct.

The bars thus far illustrated are held in place in the furnace simply by their own weight. In case the bar is light and narrow, it is necessary to keep it in place by some form of fastening. Fig. 5 illustrates what is known as the interlocking grate bar. The grate is built up of the three kinds of bars shown. Starting at the side wall of the furnace with a No. 1 bar, a No. 2 bar is set next, and so on alternately until the middle of the furnace is reached. Then the grate is built up from the other side in the same manner. This leaves two No. 2 bars next to each other at the middle. A No. 3 bar is placed between them, and the cotters are driven through the lugs on the central bar. These cotters extend across under the bars on either side and effectually lock the whole grate.

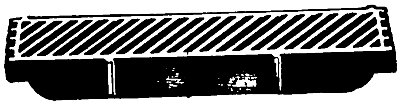


FIG. 4.

It will be noticed that all grate bars are made of considerable depth and that this depth is greater at the middle than at the ends. When a bar is in place in the furnace, it is supported at the ends and loaded uniformly, so that the greatest bending moment occurs at the center, and hence the section should be strongest at that point. An additional reason for using a deep web is that the top of the bar may become red hot, and if the web is deep this heat will be conducted into it, thereby giving a greater convection surface, which preheats the air and also cools the bar.

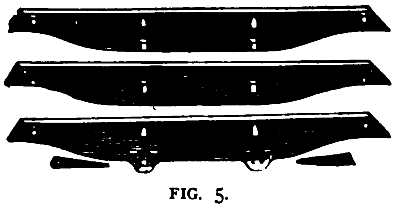


FIG. 5.

Wrought iron is occasionally used in the construction of grates, but as it softens under the effects of heat, grates made of it usually consist of pipes through which a water circulation is maintained in order to cool them. An excellent example of this is the down-draft furnace illustrated by Fig. 6, intended for use with bituminous coal. The upper grate consists of a number of wrought-iron pipes, *A*, connecting two drums, *B* and *C*. These drums extend entirely across the furnace, the larger one being subjected to the heat radiated from the fire as well as that of the gases. Both drums are connected to the boiler below the water level. The smaller drum being placed at a lower level than the larger, and in a position more protected from intense heat, a circulation is set up, the water passing down the pipe *D* into the drum *B*, thence through the grate bars *A* to the drum *C*, and up into the boiler through the pipe *E*. The fresh fuel is fed to the upper grate, where it cokes, the gases being distilled and passing down through the grate to the lower furnace chamber. The wrought-iron bars being widely spaced, the coked fuel falls through to the lower grate, where it burns brightly and heats the air admitted through the ash pit, so that when the combustible gases distilled from the coal enter the lower furnace, the best possible conditions exist to produce complete combustion and smokelessness.

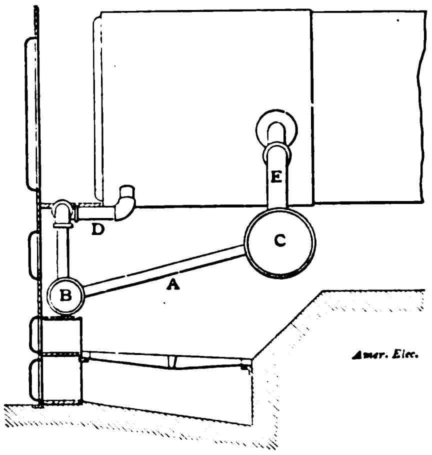


FIG. 6.

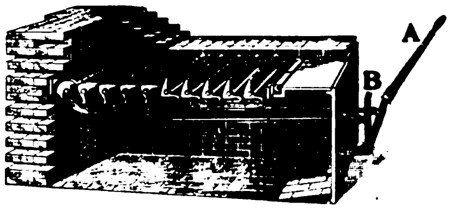


FIG. 7.

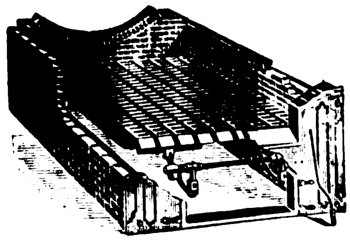


FIG. 8.

The disadvantage of using stationary grates is that the fire is not easily cleaned. Unless the air spaces are kept free of clinker and ashes, the combustion is hindered and the fire rendered sluggish. Nevertheless it is wasteful of fuel to clean the fire repeatedly, or to make frequent use of the slice bar, for the reasons that the finer portions of the fuel are sifted into the ashpit if the fire is broken up, and the volumes of cold air admitted while the fire-door is open chill the fire and lower the furnace temperature. To facilitate cleaning of the fires without opening the fire-doors, to maintain a clean grate and a fairly uniform furnace temperature, and to obviate the loss due to the smaller particles of fuel falling into the ashpit during the cleaning process, rocking and shaking grates have been designed. They are composed of individual grate bars mounted in a suitable framework, and so arranged that the bars may be given a sliding or rocking, or vertical motion, by means of levers operated from the front of the boiler outside the setting.

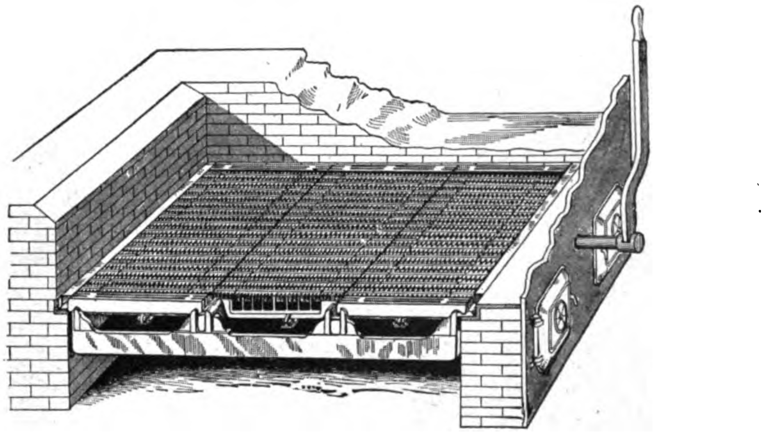


FIG. 9.

A well-known type of rocking grate is illustrated by Fig. 7. It consists of a number of separate bars extending laterally across the furnace and furnished with journals at each end which fit into boxes in the side bearing bars, thus permitting the grate-bar to rock to and fro. The grate is divided into two sections and the bars composing each section are joined together, as shown, by a common connecting bar to which the shaking lever *A* is connected by a rod. This arrangement makes it possible to clean either section of the grate without disturbing the other. Cleaning the fire is a simple matter. The clean fire on the front section is pushed back upon the rear section and the front section is dumped by pulling the lever *A* forward, as shown, after which it is returned to normal position and the live coal pulled forward upon it, while the rear section is cleaned. Then the fuel is evenly spread over the grate surface. The handle is made so that it can engage either or both of the shaking levers, thus allowing the sections to be shaken separately or together. In order to keep the air passages free from ashes, it is only necessary to place the handle on both levers and give it a slight motion to and fro. By repeating this at frequent intervals the fire may be kept in excellent condition. The bars are made so as to give as much air space as is consistent with strength and durability. This grate is particularly well adapted to the burning of the smallest sizes of anthracite, in which case the air spaces are not more than 3-16 of an inch wide.

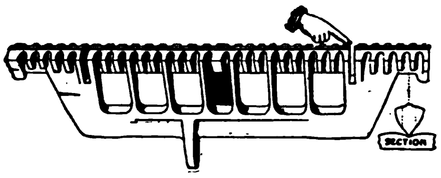


FIG. 10.

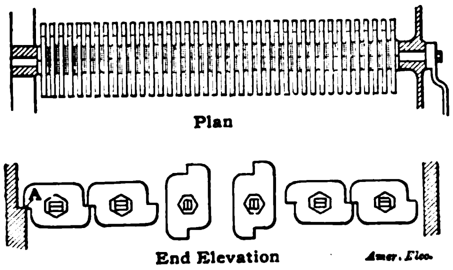


FIG. 11.

In the shaking grate shown in Fig. 8 the bars run lengthwise of the furnace and rest upon swinging bars to which the bracket is attached by a link. The shaking lever is put into the socket and moved up and down, imparting to the grate-bars a vertical and a horizontal motion, which opens the air spaces and thoroughly cleans the under surface of the fire. The bars are made of such section as to resist warping under the effects of the heat of the furnace, and yet present a large and efficient air space.

The temperature of a steam boiler furnace may rise to a point at which cast iron will melt, and trouble is frequently experienced with the burning of grates, especially if the iron is at all soft. This trouble is aggravated when the grate bar is made up of many small, thin fingers or fins. A grate which is designed to overcome this difficulty is illustrated by Fig. 9. In this type, the individual bars are but 1½ inches wide, the webs or fins being very short. A larger view of the bar is given in Fig. 10. The depth of the bar is considerable, but it is made of a skeleton character to reduce its weight. The great depth is necessary to prevent warping, and much of the heat received from the fuel is conducted into the lower portion of the bar, where it is taken up by the air supply. The expansion of the top of the bar is taken up by the two narrow slots shown which give considerable elasticity. These bars are placed lengthwise of the furnace, as shown in Fig. 9, and are rocked from side to side by a lever at the front of the boiler.

A revolving grate, which involves the principle of the shaking and rocking grate, is shown in Fig. 11. In the plan view a single bar is illustrated, extending from the front to the rear of the furnace. A number of these units are placed side by side until the desired width of grate is obtained. Each unit or bar is composed of a number of discs, of the shape shown in the end view, mounted on a revolving shaft which is turned by a lever at the front. The discs of one row rest against those of the next row, and by giving one side row a bearing on the furnace wall, as at *A*, the entire grate may be locked.

The bars of a grate are supported by what are known as bearing bars, shown at *A* and *B*, Fig. 12. These may be made of angle iron or of the cast iron T section shown. The latter is preferable, since it is much stiffer and is not so liable to be affected by the heat as a wrought iron bar. These bars extend across the furnace at the front and at the rear and rest upon the side walls or are supported by iron legs. Many of the shaking grates are constructed so as to be self-supporting, and independent of the boiler setting. This permits their installation or removal without tearing down the setting to any extent. The dead plate *C* is a cast-iron plate reaching from side wall to side wall at the front of the furnace. It forms the bearing in many cases for the front ends of the grate bars and at the same time gives a surface on which fresh coal is piled, where bituminous coal and the coking system of firing are used. It is provided with strengthening ribs underneath, to prevent warping.

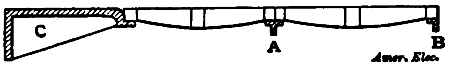


FIG. 12.

The use of blowers as an aid to combustion seems to have gained some favor, especially where smoky coals are used. Generally these blowers consist of a steam jet or a circle of jets so arranged as to entrain a volume of air and force it into the furnace. Figs. 13 and 14 show the forms of blowers referred to. These may be placed in the side walls of the furnace or in the fire doors. When thus located, comparatively cold air is forced over the surface of the fire, and this is opposed by many as being disadvantageous in that it chills the gases and supplies excess air when it is not needed, thereby causing a loss. It is suggested that if blowers must be used, they be so located as to discharge into the ash pit, so that the air supply shall be preheated by passing through the bed of incandescent fuel on the grate.

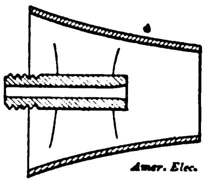


FIG. 13.

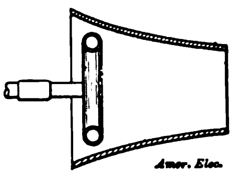
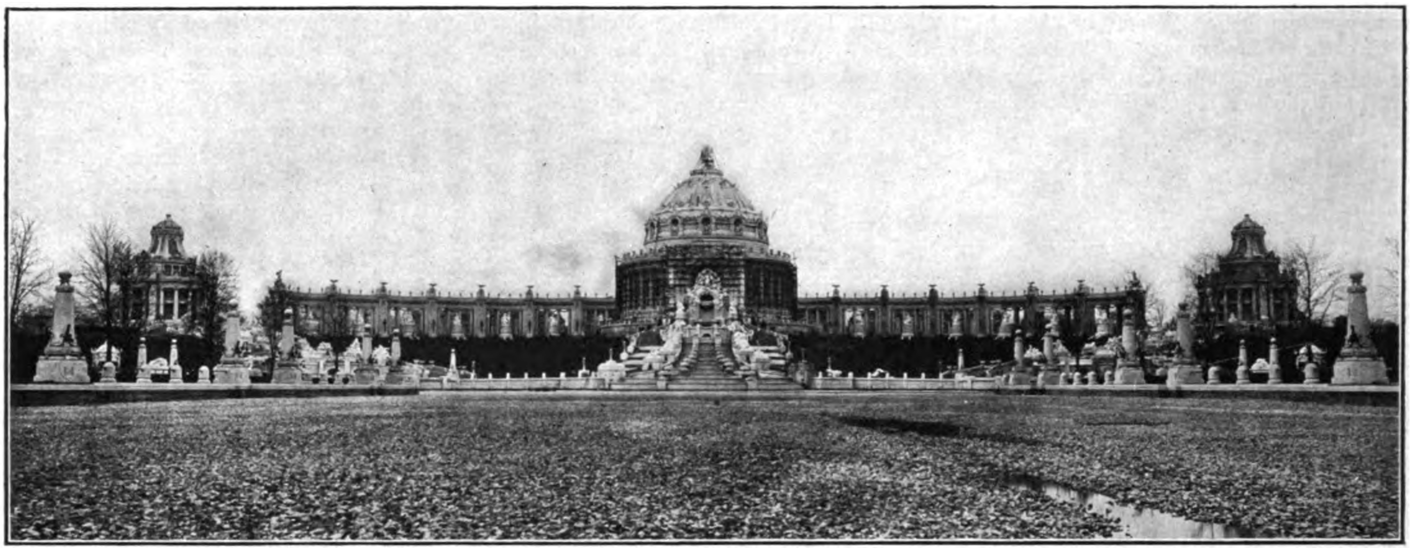


FIG. 14.



FESTIVAL HALL AND THE CASCADES.

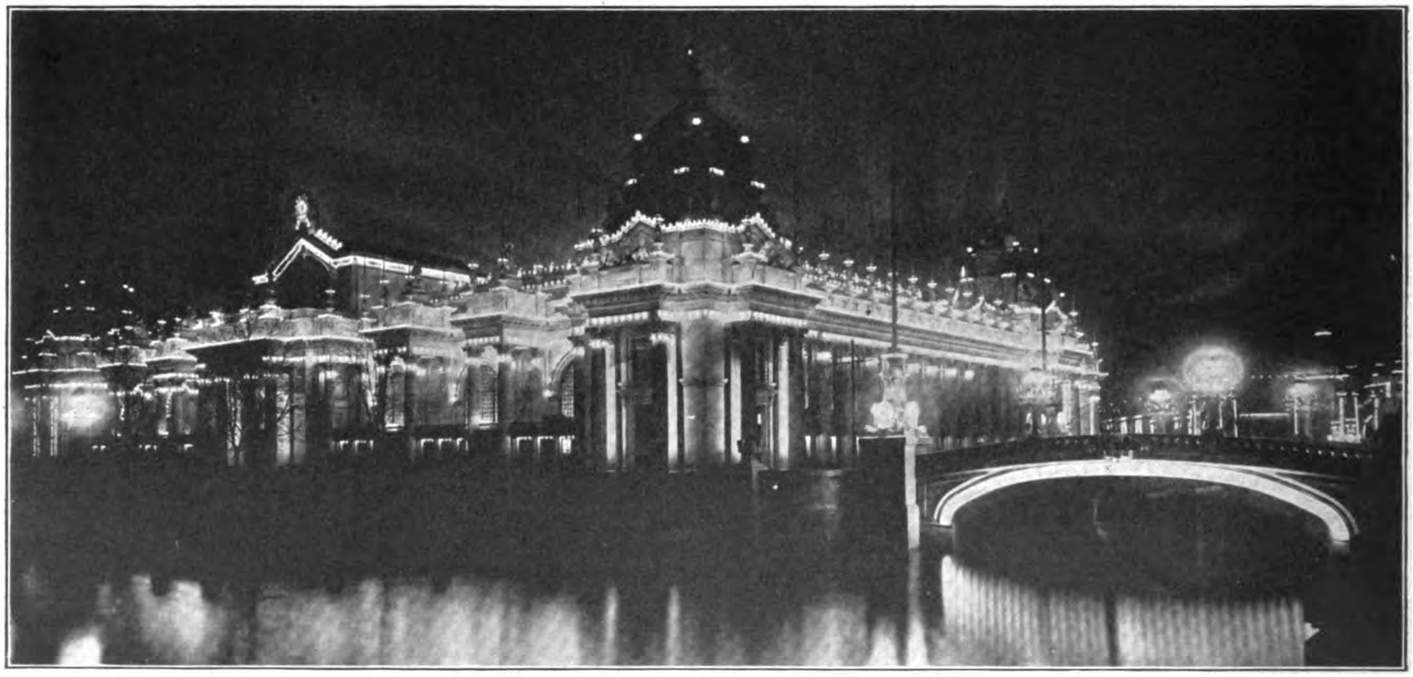
THE LOUISIANA PURCHASE EXPOSITION

After years of elaborate preparation, the great fair at St. Louis was formally opened on April 30; and notwithstanding that the vast array of buildings, the exhibits they contain, and the immense site of the exposition are not fully complete, everything indicates that the Louisiana Purchase Exposition will overshadow both in size and scope all previous expositions of world-wide importance. Life and motion abound throughout. Exhibit buildings become, in many respects, great workshops. The essence of every important art and industry is put in concrete form before the general inquirer, and a world of material is brought together for the information of the technician.

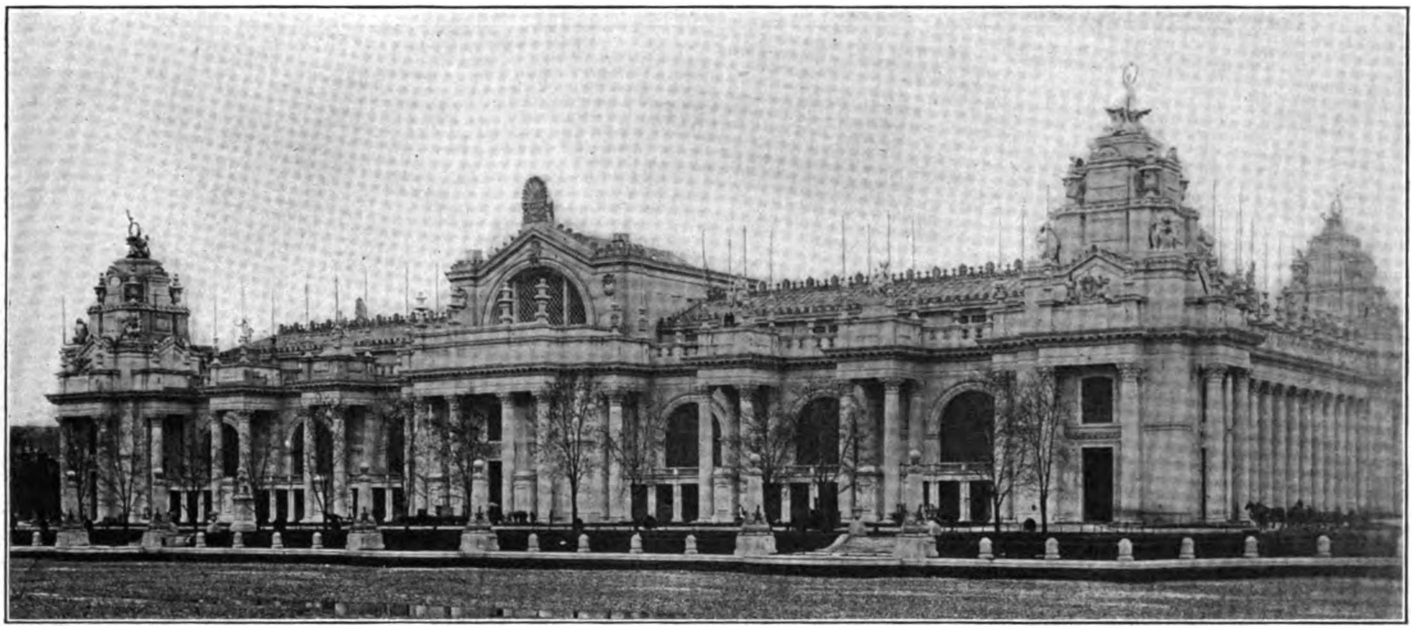
The exposition grounds cover a tract approximately two miles long and one mile wide on the western border of the city limits, the area being 1240 acres. This is for the most part level ground; but there is enough variation to give good opportunity for attractive landscape work. To the northeast lie the main group of exhibit buildings consisting of twelve great structures in symmetrical arrangement, somewhat in the form of a lady's fan, the avenues or courts corresponding to the ribs. The three Palaces of Art stand on a plateau 60 feet above the general level of the other buildings of the main group. Northeast from them is a natural amphitheatre sloping down to a great basin. Down the slopes of this amphitheatre fall three series of cascades with elaborate decorative arrangement. At the brow of the hill above the cascades is a long curved architectural screen. In the center 200 feet high stands the majestic Festival Hall. Below on the three courts, or avenues, radiating from it stand the structures dedicated to Liberal Arts, Mining, Metallurgy, Manufactures, Education, Varied Industries, Electricity, Machinery and Transportation.

From the north side of the Festival Hall at the brow of the hill, a flood of water gushes forth spreading out into a 50-foot stream. The first fall is 25 feet, then a series of cascades for a distance of 290 feet with a total fall of 90 feet. At the Grand Basin, the stream is 152 feet wide. At the sides are two great fountains with cascades 20 feet wide at the top and 50 feet wide at the point where the stream falls into the great basin. All the streams flow into the cascade basin forming a part of the lagoon system. At night the cascades are illuminated from below by vari-colored lights.

This great artificial water-fall while serving as the central feature of the exposition panorama also serves as a cooling tower for the condensing water used by the ex-



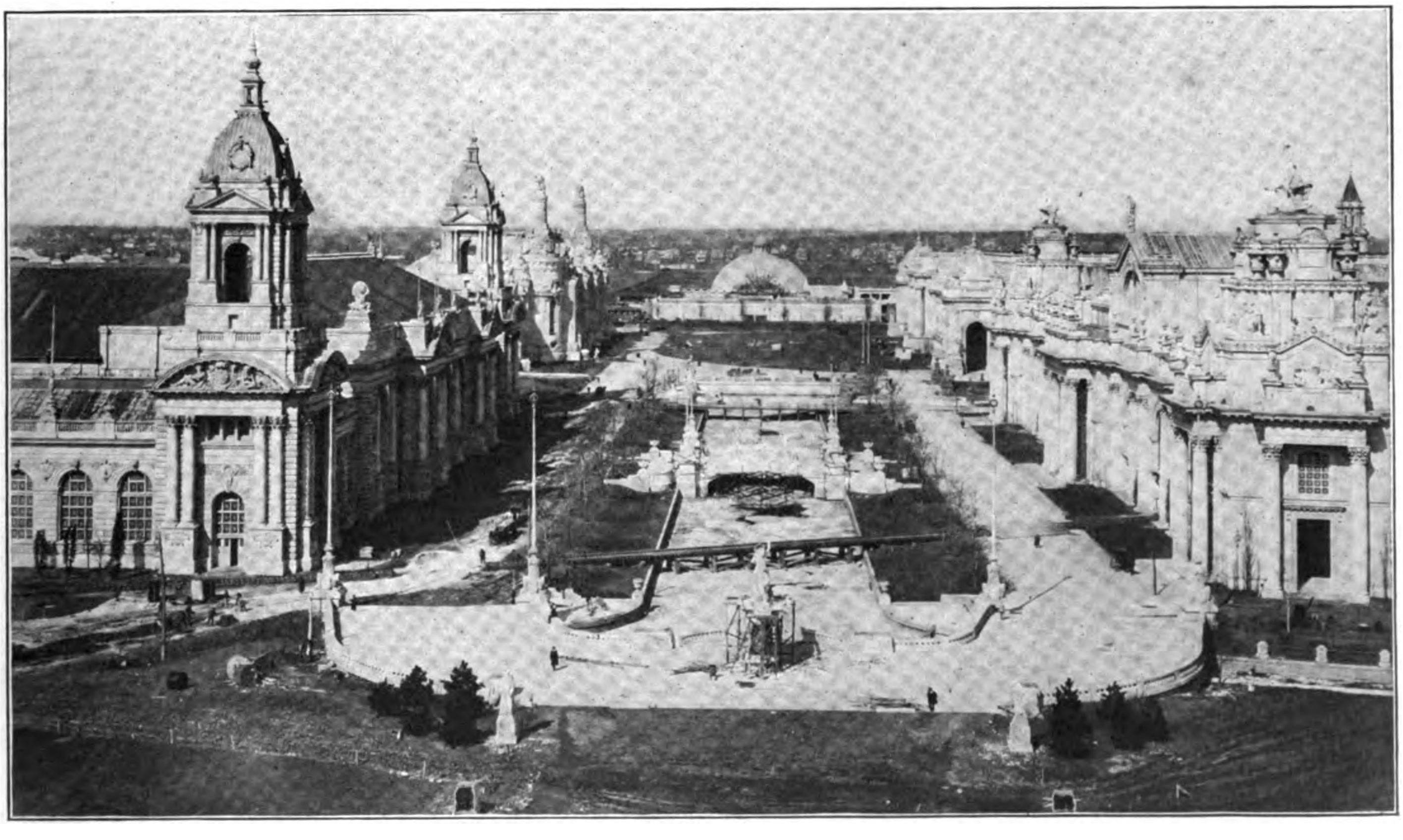
RESPLENDENT NIGHT VIEW ON THE GRAND BASIN.



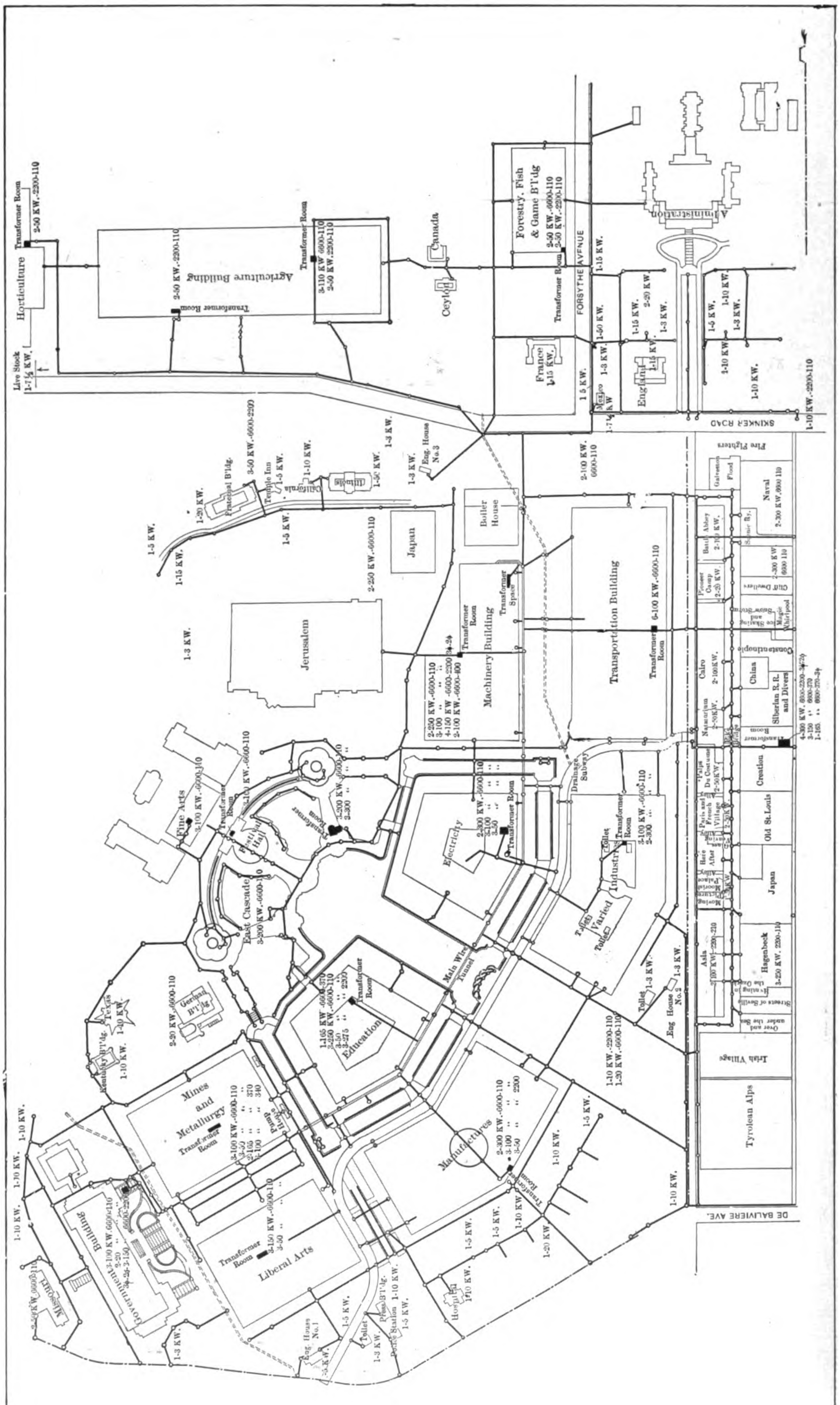
PALACE OF ELECTRICITY.

position power plant, and in this way becomes useful as well as ornamental. The cascade pumping plant consists of three 2000-h. p. Westinghouse induction motors direct-connected to Worthington centrifugal pumps each with a 36 in. discharge and a 40 in. suction. The water is pumped at the rate of 15,000 gallons per minute.

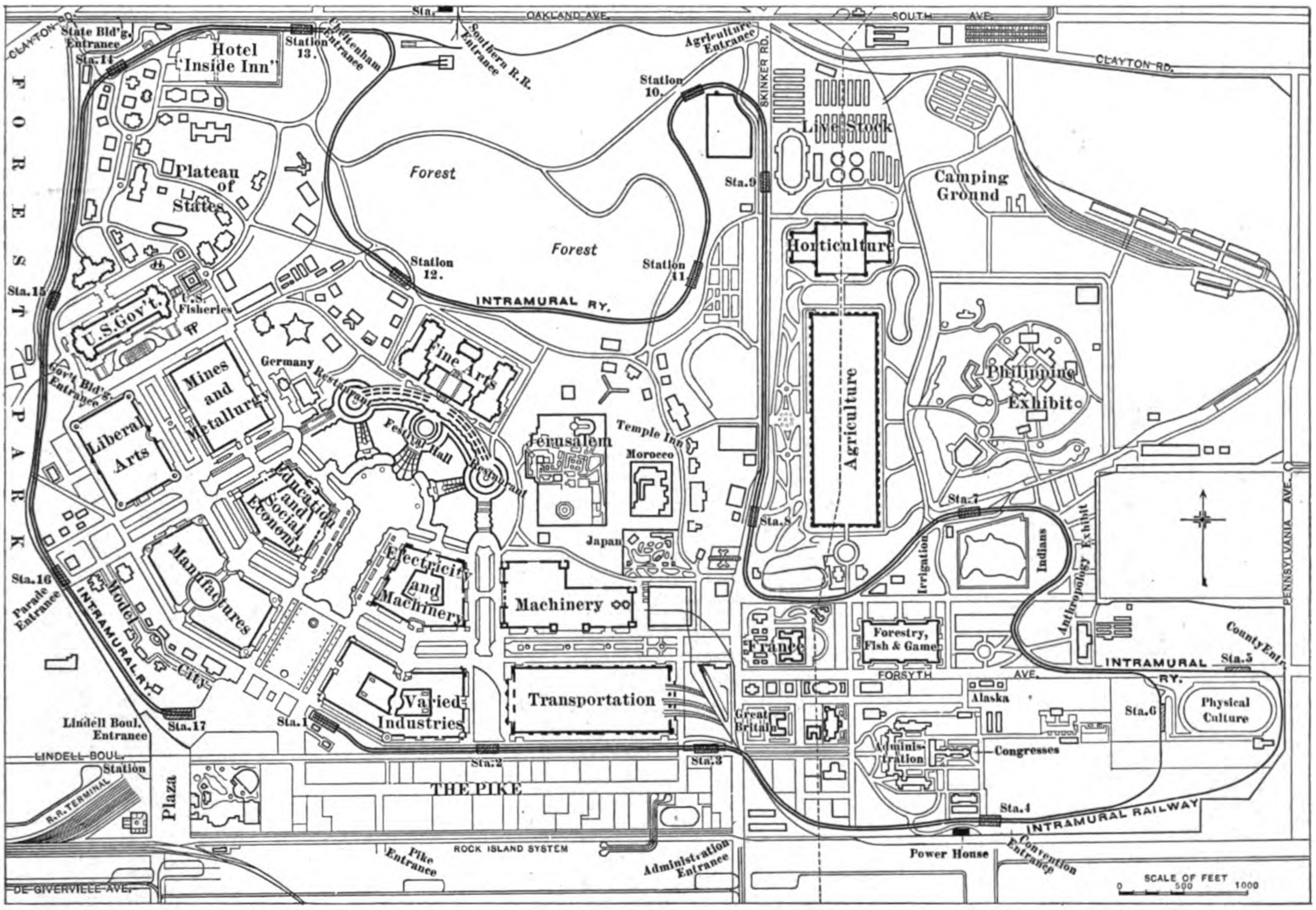
On the west court are located the Palaces of Electricity, Machinery and Transportation, and in them are contained most of the apparatus of interest to electrical and steam engineers. The Palace of Electricity covers an area 525 feet by 750 feet. In the gallery over Sections 1 and 2 are the offices of the department, jury and committee rooms. With this exception there is no second floor to any part of the building. In Section 1 facing Aisle B are the offices of the AMERICAN ELECTRICIAN. Telegraph exhibits and the main exposition offices of the Postal and Western Union Telegraph companies occupy the same locality. Near the center of Section 4 is located the sub-station which contains transformers, switchboards and rotary converters through which the high-potential alternating current is received from the service power plant and transformed to a lower voltage or converted to direct current for lighting and operating exhibits. This machinery was furnished chiefly by the General Electric and Westinghouse companies. Adjoining the station the latter company is installing one of the largest exhibits in the building, embracing the varied branches of electrical machinery and apparatus. Across Aisle B are the electric railway trucks and locomotives of Burnham, Williams & Co. Along the north side of Section 3 the Standard Underground Cable Company and the McRoy Conduit Company are installing a model conduit system. A very conspicuous object is a Burdette-Rowntree electric dumb waiter running from the floor to the roof above Section 3. Its operation is automatic. Over Sections 3 to 17, along the west side of the building, is the craneway.



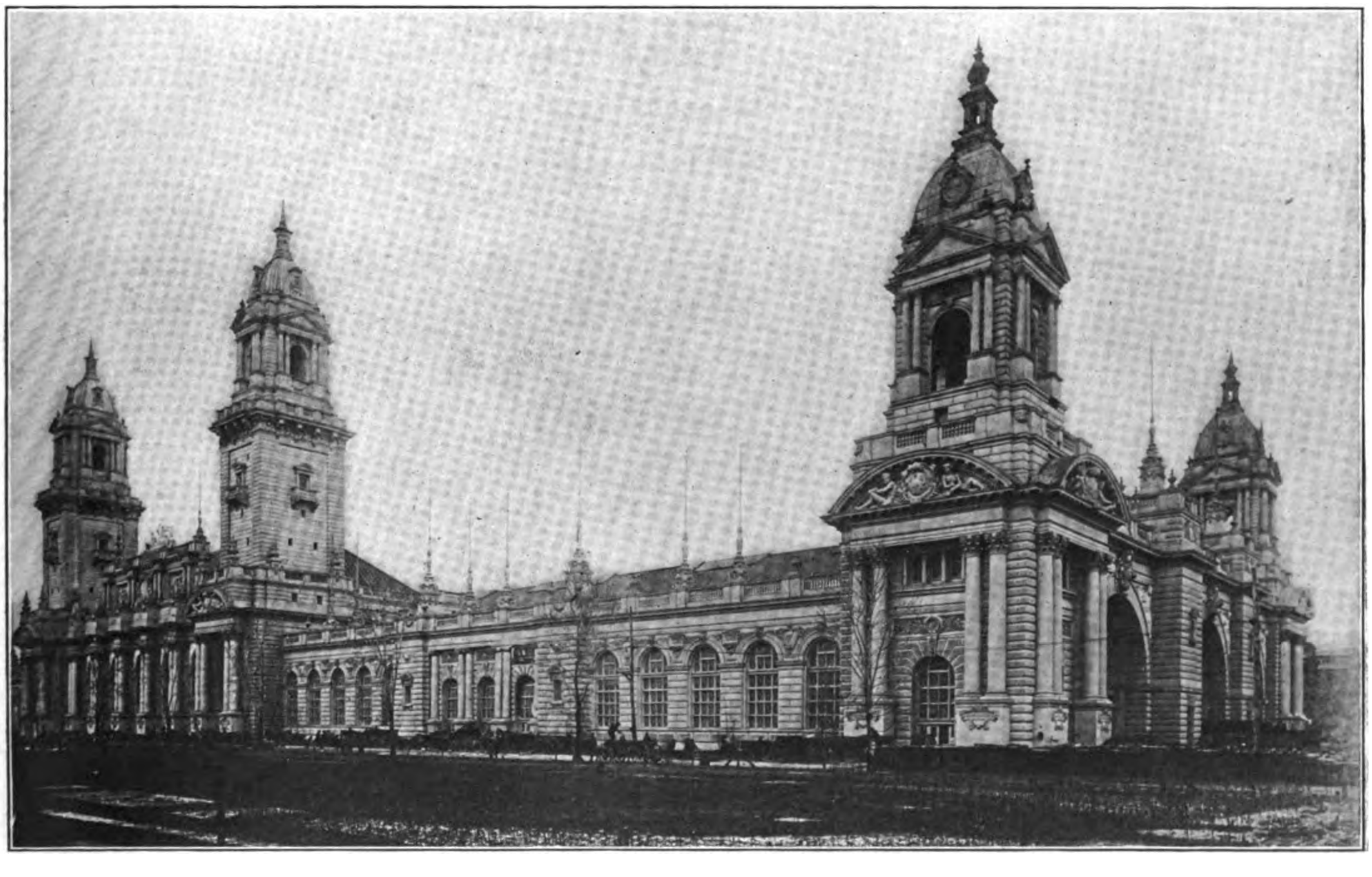
PANORAMIC VIEW SHOWING THE PALACES OF MACHINERY, TRANSPORTATION, VARIED INDUSTRIES AND ELECTRICITY.


Horticulture
Agriculture Building
Forestry, Fish & Game B'l'dg
Administration
Canada
Ceylon
France
England
Mexico
FORSYTHE AVENUE
SKINKER ROAD
Live Stock
Fire Fighters
Galveston Flood
Naval
Japan
Boiler House
Machinery Building
Transportation Building
Jerusalem
Fraternal B'l'dg
Temple Inn
California
Illinois
Eng. House No. 3
Fine Arts
Festival Hall
East Cascade
German B'l'dg
Texas
Kentucky B'l'dg
Electricity
Varied Industries
Drainage Subway
Main Wire Tunnel
Education
Mines and Metallurgy
Pump House
Manufactures
Liberal Arts
Government Building
Missouri
Hospital
Eng. House No. 1
Eng. House No. 2
Press B'l'dg.
Police Station
Pioneer Camp
Battle Abbey
Cliff Dwellers
Constantinople
Cairo
China
Siberian R.R. and Divers
Creation
Old St. Louis
Japan
Asia
Hagenbeck
Irish Village
Tyrolean Alps
DE BALIVIERE AVE.
Transformer Room

GROUND PLAN OF THE LOUISIANA PURCHASE EXPOSITION, SHOWING DISTRIBUTION SYSTEM WITH LOCATION OF POWER PLANTS, SUB-STATIONS, TRANSFORMER ROOMS AND OUTPUT CAPACITY.


OAKLAND AVE.
SOUTH AVE.
CLAYTON RD.
State Bld'g. Entrance
Sta. 14
Hotel "Inside Inn"
Station 13.
Cheltenham Entrance
Southern R.R. Entrance
Agriculture Entrance
Station 10.
SKINKER RD.
Live Stock
Camping Ground
FOREST PARK
Plateau of States
Forest
Forest
Sta. 9
Horticulture
Station 12.
Station 11
INTRAMURAL RY.
Sta. 15
U.S. Gov't.
U.S. Fisheries
Gov't Bld'g. Entrance
Germany
Restaurant
Fine Arts
Mines and Metallurgy
Liberal Arts
Festival Hall
Restaurant
Jerusalem
Temple Inn
Moroceo
Agriculture
Philippine Exhibit
Education and Social Economy
Sta. 8
Sta. 7
Irrigation
Indians
Anthropology Exhibit
PENNSYLVANIA AVE.
Japan
Sta. 16
Parade Entrance
Manufactures
Electricity and Machinery
Machinery
Model City
France
Forestry, Fish & Game
County Entr.
INTRAMURAL RY.
Sta. 5
FORSYTH AVE.
Transportation
Varied Industries
Alaska
Sta. 6
Physical Culture
Great Britain
Lindell Boul. Entrance
Sta. 17
Sta. 1
Administration
Congresses
LINDELL BOUL.
Station
Sta. 2
Sta. 3
R.R. TERMINAL
Plaza
THE PIKE
Sta. 4
INTRAMURAL RAILWAY
ROCK ISLAND SYSTEM
Pike Entrance
Administration Entrance
Power House
Convention Entrance
SCALE OF FEET
0 500 1000
DE GIVERVILLE AVE.

PLAN OF EXPOSITION GROUNDS.



PALACE OF MACHINERY.

Upon this is a four-motor, 30-ton electric traveling crane furnished by Pawling & Harnischfeger. A 20-h.p. 220-volt motor gives a horizontal speed of 250 ft. per minute, and an 8-h.p. motor gives a trolley transverse speed of 150 ft. The main hoist is equipped with a 30-h.p. motor with a speed of 25 ft., and the auxiliary hoist with a 15-h.p motor, and has a travel from 30 to 90 ft. per minute.

FRANKLIN.

In the northwest corner are several displays of electric railway equipment. The electric and air brake apparatus of the National Electric Company is shown as well as a line of alternating and direct-current generators and motors. Block 9 is equally divided between the Fort Wayne Electric Works and the Wagner Electric Manufacturing Company, both putting in working exhibits. The remaining space adjoining the court is occupied by the Bullock Electric Company and will be one of the notable machinery exhibits. A 6600-volt alternating current is received and transformed to 340 volts for a rotary converter which supplies 500-volt direct current for operating street railway apparatus. Other motor-generators and balancing sets furnish current for multi-voltage system as applied to speed control for machine tools. The individual feature of this exhibit is a model testing floor, indicating the best methods of testing electrical machinery before it goes to the customer. Under the traveling crane the Northern Electrical Manufacturing Company will have a complete demonstration of the adaptation of electric motors to every form of tool. In this exhibit the manufacturing of motors is carried out in a way to show the convenience and increased efficiency of motor-driven tools. All of Block 17 under the craneway is taken by the Western Electric Company. Near the center is a large 100-kw. motor-generator set which, with a compensator, furnishes 110 and 220-volt direct current throughout the exhibit. Next Aisle B is a small machine shop in operation, showing the direct application of motors to tools. There are several direct-connected marine sets, transformers and regulating apparatus. On the opposite side is a series of alternating arc light equipment with ornamental lamps and stands.

There are two collective exhibits, embracing nearly all electrical classifications, one by the Wesco Supply Company, of St. Louis, in Block 8, and another by Ewing-Merkle covering a portion of Block 14. In the former a large Warren synchronous motor drives a Triumph generator supplying power for the motors and apparatus in operation. In the second exhibit the Commercial Electric Company has a number of direct-current motors from 1¼ to 35 horse-power, and a 30-kw. three-bearing generator direct-connected to a gas engine, which furnishes power for the other exhibit items. A special feature is a line of variable-speed motors designed for operating on any standard two-wire system, with single voltage, and which will give speed variations of from 4 to 1, with horse-power and efficiency practically constant at all speeds, and little if any variation of speed at all loads with the controller set at a given point.

The western entrance embraces two large spaces, which are occupied by unique exhibits. The Carman Projector & Specialty Company shows stereopticons, lanterns, projectors and automatic electric curtain hoists in operation. Opposite is the electroplating exhibit of the Hall Gold & Silver Plating Works. The different processes of plating and finishing of plated wares are shown in a most attractive manner. The Gould Storage Battery Company and the Gould Coupler Company have a fine combination exhibit in Section 16. In the northern half of Block 16 is placed the artistic exhibit of Japan. This electrical apparatus was designed and made by Japanese. The Italian space, occupying Block 18, is especially worthy of notice on account of the scientific and electrical measuring instruments therein.

HENRY.

The three 75-ft. towers of the De Forest

PALACE OF ELECTRICITY BY NIGHT.

Wireless Telegraph Company support the antenna from which wireless messages are sent and received from other stations in the building and to the large station in the model city. The T. E. Clark Wireless Telegraph-Telephone Company shows a line of wireless apparatus in operation, and the adaptation of such apparatus to fire alarms and safety signalling on railroads. Two wireless telephone stations at opposite ends of the building are used by A. F. Collins to demonstrate the newest application of electricity to the transmission of intelligence. Two telephone operating exchanges are in the south side of the building, both enclosed by handsome booths. Section 17 is occupied by the exchange of the American Telephone & Telegraph Company. This connects with the local and long-distance lines of the Bell Company, so that there is direct communication from the building to all parts of the grounds, city and all points reached by telephone lines. In Section 24 the exchange of the Kellogg Switchboard & Supply Company gives a similar service through its connection with the Kinloch system, of St. Louis. Recent developments of automatic and semi-automatic telephone systems are shown in a thorough manner by the Automatic Electric and the Fuller Automatic Telephone Exchange Companies. An instructive historical collection of telephone apparatus is to be arranged by B. F. Wasson in Block 25. In a fine booth erected by the Hutchinson Acoustic Company are exhibited the "Acousticon" and "Massacon," through whose instrumentality deaf mutes are made to hear and taught to speak. Two beautiful booths in Section 25 are those of the Holophane Glass Company and the Weston Electric Instrument Company, the latter showing a full line of standardizing electrical instruments. The brilliant illumination of the Holophane exhibit is very conspicuous, as 1000 incandescent lamps cover the exterior and interior of their handsome structure. The laboratories of the National Bureau of Standards, covering a space of 23 by 200 ft., contain over $50,000 worth of instruments for testing every kind of electrical machine and apparatus. About twenty government experts are connected with the laboratories to conduct tests and investigations.

PALACE OF TRANSPORTATION.

The largest individual exhibit is that of the General Electric Company, embracing Section 28, and covering a quarter of an acre of floor space. A great variety of electrical apparatus manufactured by this company is installed and will be shown in operation. The Edison exhibits are in Sections 26 and 27, and include the iron-nickel storage battery and a historical collection of great merit. The purification of water by electricity is shown by the Standard Water Purifying Company, in Block 33, and water free from all forms of organic life will be served to visitors. In the northeastern part of the building are the German and French collections of electrical exhibits; the former is especially strong in electrochemistry. France has the most comprehensive display of any foreign country, covering as it does every classification. In the eastern half of Block 7 England is making an excellent showing of its electrical products.

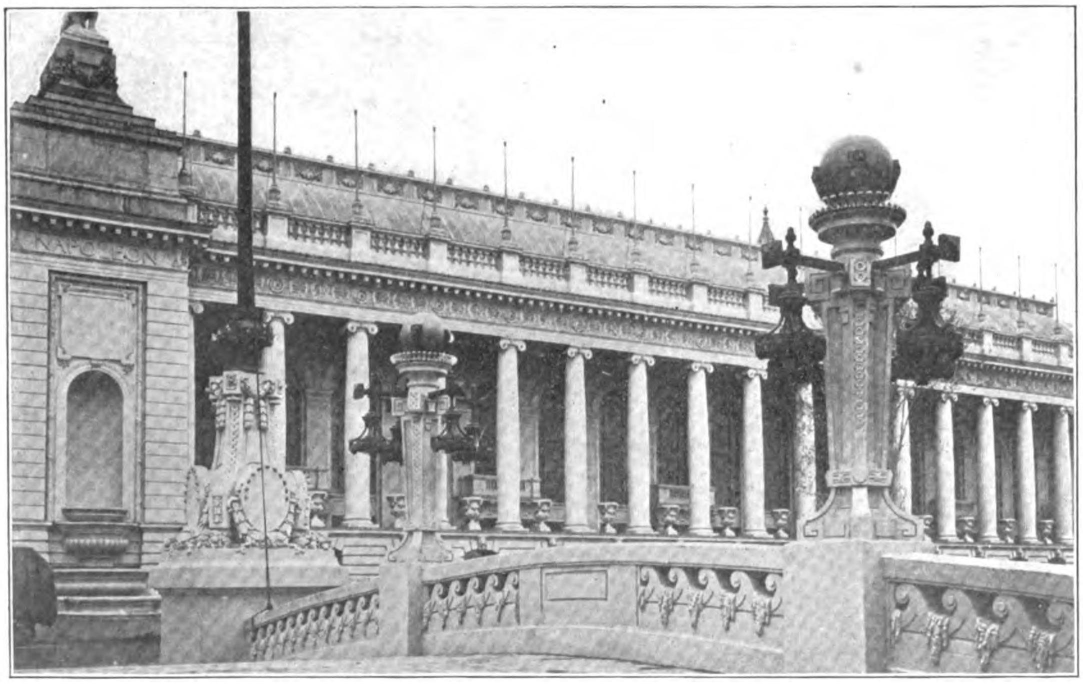
INTERIOR OF MACHINERY PALACE.

This outline of the exhibits placed in Electricity Palace is of necessity incomplete at this time. Many companies preparing displays have not proceeded far enough with their installations in the buildings for any account to be given.

Machinery Palace is a superb structure 1000 feet in length and 525 feet in width In the eastern half is located the great power plant of the exposition. The service plant furnishes 8000 kilowatts of 25-cycle 6600-volt, three-phase current; exhibitors' apparatus supply 8000 kilowatts more of similar current, and the Union Light & Power Company of St. Louis delivers at the switchboard 7500 kilowatts additional. The total amount of 6600-volt, three-phase, 25-cycle current available is therefore 23,500 kilowatts. Besides this 2400 kilowatts of 550-volt direct current and 600 kilowatts of 250-volt direct current is furnished by exhibitors' apparatus.

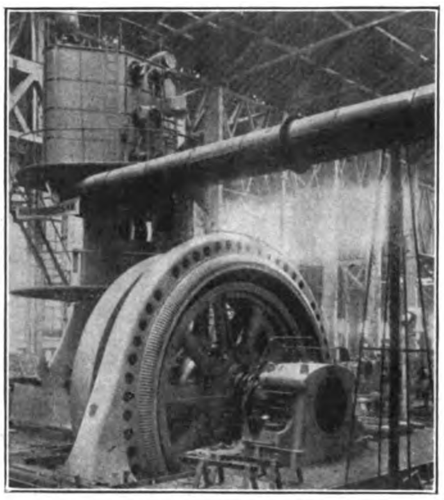
The boilers for the service plant occupy the southern portion of the exposition boiler house. There are eight batteries, each consisting of two 400-h.p. water-tube boilers, having a total capacity of 6400 horse-power. All are equipped with mechanical stokers fed from coal bunkers above, through swinging chutes. The coal bunkers, in turn, are supplied by means of a complete installation of coal conveying apparatus which receives the coal from the hopper located between the rails of a sliding of the Terminal Railway Company. Ash pits under each of the boilers receive the ashes as they fall through the grates. An underground tunnel provided with tracks and ash cars furnishes the means for readily emptying the pits. The plant is so well provided with labor-saving devices that from the dumping of the coal into the hoppers to the removal of the ashes almost no manual labor is employed. The northern portion of the boiler house contains various types of boilers placed as exhibits. These present a very interesting appearance because of the many types represented. They include besides the representative American makes several of European manufacture. Fuel is delivered to all this group by means of an overhead conveying system, and all of the boilers feed into common steam mains, supplying the exhibit engines in the Palace of Machinery. All of the large boilers are provided with systems of induced draft. The boiler house is situated about 100 feet west of the Palace of Machinery.

The four engines of the service plant are all of the same type—Westinghouse, Corliss, vertical, cross-compound. Steam is supplied to them through two 12-in. steam mains. Two of the four generators of this installation are of Westinghouse type, rated at 2200 kilowatts. The remaining two, of 2000 kilowatts' capacity each, are of General Electric Company manufacture. The exhibit installations lying to the east of the service plant consist of several units remarkable for their size and features of design. The most powerful of these is the Curtis steam turbine rated at 8000 horsepower. The space occupied by this machine leads the casual visitor to consider it much less powerful than its neighbor the Allis-Chalmers 5000-horse-power engine coupled to a 3500 kilowatt Bullock generator. This immense engine presents quite a distinctive appearance, its vertical cylinder standing far above the surrounding machinery. Grouped around the larger units are a number of installations ranging in size from 500 to 2000 kilowatts. Lying to the north are those of smaller capacity.



BRIDGE ACROSS A LAGOON, SHOWING DISPOSITION OF LIGHTS.

For the distribution of the current from the main switchboard at the west end of Machinery Palace to the eighteen-sub-stations situated in the various buildings, a complete system of subways has been constructed. These are of a temporary nature, consisting simply of a ditch whose sides as well as top and bottom are boarded over. A few inches of dirt thrown on top hides all evidences of the existence of the subway.



3500-KW. GENERATING UNIT.

Shelves built on both sides of a central passage carry the cables. The largest of these subways measures about seven feet by seven feet. Telephone, telegraph and fire-alarm cables, as well as high-potential power lines, are carried in the same subways. The former are placed on the upper shelves. The power cables, carried on the lower shelves, are lead-sheathed, the three cables of the three-wire system being enclosed in one sheath. Where the distributing system passes under the lagoons and waterways, the wood subways are naturally dispensed with, and at these points a water-tight cement conduit is installed. In most of the buildings the demand for power is limited to alternating current. The sub-stations in these cases consist simply of transformers and the accompanying switchboards.

The machinery exhibits in several of the buildings, however, demand direct current for their operation. In the sub-stations of these buildings—including the Palaces of Electricity, Education and Mines and Metallurgy—rotary converters are installed. In the Palace of Electricity the demands for direct and alternating current at so many voltages and of such frequencies resulted in the installation of the most complete sub-station on the exposition grounds. As the separate items composing the display here are placed as exhibits, the fire-proof construction used in making the enclosures for the sub-stations of the other buildings was omitted, ample precaution being taken by installing the machinery and transformers on a concrete floor and allowing sufficient space for all needs between these and the other exhibits. Four complete sets of three-phase transformers are installed. These range in size from 75 kilowatts to 250 kilowatts, the station having a total transformer capacity of 1575 kilowatts.

The converting apparatus consists of one 200-kw. 550-volt rotary converter, supplemented by two 100-kw. 125-volt motor-generator sets, one for each side of the three-wire 110- and 220-volt systems with which the building is supplied. A switchboard with the necessary panels for distribution and connection is placed in the central portion of the 1400 square feet occupied by the sub-station. The high-tension leads are brought directly to the transformers from conduits under the floor. The transformed and converted current is led to the upper portion of the building by means of a post located on the sub-station space. That part used for lighting the exterior of the building is conducted to distributing boards on the roof. The cables supplying power and light for the exhibits are strung on trusses overhead, from which leads to to the separate exhibits are dropped. The capacity of the transformers in the sub-station of the Palace of Electricity does not by any means represent the total amount of power available in this building. Several of the exhibits include complete transforming and converting sets.

The great number of different combinations of frequency and voltage demanded by the exhibitors in the Palace of Electricity, and the readiness with which these demands were met, show very pointedly the flexibility of the alternating-current systems. In alternating current six different voltages are supplied, ranging from 104 to 6600 volts. These, together with the three frequencies (25, 50, and 60 cycles) and the one-, two-, and three-phase systems, give a possibility of fourteen different combinations from the 6600-volt mains.

Most of the large engines are run condensing. The Westinghouse service plant is equipped with its own cooling towers. The exhibitors' service plant takes condensing water from the lagoons. The condensers in the Machinery Palace discharge hot water into a tunnel, which runs 1100 feet to the suction of the cascade pumps. Much of this tunnel is under the lagoon. From the Machinery Palace to the lagoon a short distance away the water is taken through two 24-in. vitrified tile pipes. Under the lagoon the tunnel is 6 feet by 6 feet, with board walls. The intake for the condensers is of 36-inch vitrified pipe. This pipe is 400 feet long over all. Water runs through it by gravity to four cold wells from which it is drawn by the condensers. Two of these cold wells are 8 feet by 8 feet, and two are 14 feet 8 inches by 14 feet 8 inches.

Adjoining Machinery Palace on the north is the Transportation Palace. This building is devoted mainly to track space for exhibits of rolling stock. In this building electric railway trucks and car bodies are shown, and also some electrical apparatus. Just north of the Transportation Palace are two test tracks, to be used in electric railway testing. One of these test tracks is 1400 feet long, and the other 2000 feet. The shorter one will be used for testing slower speed apparatus on short distance runs, and the longer track for testing high-speed apparatus. This is the first exposition at which the actual testing of electric railway apparatus offered for exhibit has been attempted on a large scale.

The intramural railway, which will furnish local transportation in the exposition grounds, is located so as to form a kind of outer belt line around the principal portion of the exposition. The route of the road has been planned so that a great amount of elevated structure is not necessary. It is approximately 10 miles around the grounds by this line, and there are sixteen stations spaced conveniently along the track. Starting near the main entrance, whence a view of the Grand Basin and Festival Hall may be had, the cars pass between "The Pike" and the Varied Industries and Transportation Palaces. Then they wind about through the buildings at the western end of the grounds, turning the corner of the great Agriculture Palace and coming out upon the wooded sections beyond. After a stop at the Fine Arts Palace, the cars make their way to the extreme northeastern corner of the grounds, skirt the Government Building, Liberal Arts and Manufactures Palaces, and finally return to within a short distance of the starting point. Besides the railway, electric automobiles and push chairs are extensively used.

The power plant for the intramural occupies a space of about 10,000 square feet in the Machinery Palace. The equipment was supplied by the Crocker-Wheeler Company, and consists of seven units, having a combined generating capacity of 3500 kilowatts. Each unit is a standard Crocker-Wheeler railway type generator, direct-connected to the prime mover. There is one unit of 900 kilowatt capacity, driven by a Buckeye cross-compound engine. A 600 kilowatt generator is driven by a Lane & Bodley horizontal cross-compound engine. There are three units of 500 kilowatt capacity each, one driven by a single-cylinder rolling-mill type of Corliss engine, manufactured by the Murray Iron Works, the other two being driven by Brown-Corliss vertical cross-compound engines. The sixth unit is of 400 kilowatt capacity, and uses a Harrisburg horizontal tandem compound engine. The last generating unit in the series is driven by a Doble water-wheel, made by the Abner Doble Company, of San Francisco, the water pressure being furnished by a Jeansville Iron Works pump. The unit is of 100 kilowatt capacity.

The incandescent lamp is used to a very large extent at St. Louis for decorative lighting of the buildings, the cascades, the main feature of the fair, the bridges and lagoons surrounding these buildings. The architectural lines of each building are brought out into bold relief by thousands of 8-c.p. incandescent lamps, 250,000 of these lamps being used for this purpose, not including the energy used for the illumination of the cascades, which amounts to 2100 kilowatts. About 5000 kilowatts is used on the decorative lighting of the exterior of the buildings. Each of the large buildings has a separate feeder supplying the transformers for the decorative lighting of that building. The decorative lighting is run on a 400-volt, four-wire system of distribution. From the four-wire distributing centers two-wire circuits, carrying about 1300 watts each in 8-c.p. lamps, are run. Most of the wiring for decorative lighting is on knob and in tube. Open work has been wired with slow-burning weather-proof insulation on the wires, and concealed work has been wired with rubber-covered wire. The interior lighting of the buildings by the exposition is designed simply to be sufficient for patrol purposes. The lighting is to be done by 50-cycle, alternating-current enclosed arcs, taking 6.5 amperes, which are run on circuits of about 3500 volts maximum. The constant-current transformers for arc lighting are located in Machinery Palace. About 1200 kilowatts is used in such arc lighting. This lighting is run from alternating-current generators in the exhibitors' power plant. A limited amount of 110, 220 and 500-volt direct current is available in each principal building. The three-phase alternating-current circuits for general commercial uses in each building, such as exhibitors' lights and motors, will be supplied by a feeder to each building run independently of the decorative lighting for that building.

The current supplied by the Union Light & Power Company is used on the decorative lighting. This current is taken first to the main switchboard in Machinery Palace over three feeders. Where these feeders enter the grounds there is a terminal house, in which are located water rheostats, employed for putting the decorative lighting load on gradually. The gradual bringing up of all the decorative lighting from dark-

VIEW FROM PALACE OF ELECTRICITY ACROSS CASCADE BASIN, SHOWING PALACE OF EDUCATION.

ness to full brilliancy was one of the most popular and beautiful features of the Pan-American Exposition. This method of bringing on the load was also highly desirable from the power company's standpoint, as it gave the governors time to act and obviated strain on the apparatus. The great switchboard extending entirely across the central bay in the west end of Machinery Palace is designed for the control of all the 6600-volt, three-phase current used on the exposition grounds. It is a brick structure supported upon timber work and occupying a height of two galleries. It consists mainly of feeder panels, as most of the generator panels are located near the machines which they control. The four generators in the service plant have control panels in this switchboard. There are in all 17 feeder panels, four generator panels, three total load panels, three exciter panels, two incoming feeder panels from the Union Light and Power Company's circuits, and one rheostat panel for controlling the water rheostats employed in connection with the decorative lighting.

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SMALL CANDLE-POWER ENCLOSED-ARC LAMPS FOR CITY STREET LIGHTING.

BY J. H. HALLBERG.

Many new methods of electric street lighting have been put into practical operation during the past few years, and the public as well as the central station operators have now had opportunities to observe the results obtainable with the various systems. Of all the recent street lighting systems which have proved practically successful the small-candle-power arc lighting systems have probably attracted the most attention.

As there are comparatively few people who have the opportunity to consider the street lighting proposition from the combined standpoints of the public, the operating company and the manufacturer, a few comprehensive facts relating to small-candle-power arc lamps for street lighting may be of interest at this time.

The selection of a street arc lighting system is in most cases left with a body of city officials who have practically no experience in that line and are often influenced by what they see superficially in other cities and hear from other people. This accounts for the fact that systems are sometimes installed in towns or cities to the requirements of which they are not adapted; in some cases the lamps are not even properly spaced and are equipped with globes of unsuitable character. The small-candle-power arc lighting system requires skilful application in order to bring out its highest commercial efficiency; in this respect it differs from the high-candle-power system which is better understood and the success of which does not depend so much upon the details of application and the manner in which the lamps are operated.

The term "small-candle-power" or "low energy" applies to arc lamps consuming about 250 to 300 watts at the arc, and of these there are two general classes, one for direct and the other for alternating current; these classes may be subdivided into two types: one for multiple and the other for series operation. There are now several large installations of each kind in operation and the following may be considered to represent their average comparative values.

The small-candle-power direct-current arc lamps for parallel operation are generally operated in conjunction with an Edison three-wire system of distribution, with the lamps connected directly to the regular commercial mains. With this arrangement, it is necessary to turn on each lamp by means of a hand switch located between the distributing mains and the lamp. In order to overcome this expensive operation it has been suggested, and in some cases practised, to install automatic switches operated by clock mechanism. This scheme is beautiful on paper, but experience has proved that the automatic switches will not keep up to the standard and soon become a source of great expense and annoyance. Furthermore, these switches are very expensive to install. It is, of course, possible to run an additional wire from the power house or sub-station which will constitute one leg of the system and a switch can be inserted in this wire for switching lamps on and off. This, however, leaves the lamps "alive" after they are extinguished.

It has also been proposed to install an electromechanical switch at each lamp, the switches to be operated from the station over a small extra switch-wire which will, of course, have to be installed in addition to the required distributing mains. The cost of the extra switch circuit for a low-tension system is great and in the case of an underground system is often prohibitive. Moreover, the application of electrically operated switches in their present form complicates the system and they are expensive to install.

The usual potential on the mains of the Edison system is about 118 volts. Considering the small-candle-power arc lamp for this service, it should be built for about 3 amperes and adjusted for 85 volts, thus consuming 255 watts at the arc. This would make the commercial efficiency of this lamp at its terminals about 72 per cent. The average loss between the bus-bars in the power house and the arc lamp terminals on the Edison three-wire system of distribution, under most favorable conditions, is not less than 10 per cent. Thus the efficiency of this arc lighting system at the power house bus-bars cannot be over 64.8 per cent, and the arc lamps must be switched on and off by men employed for that purpose, or by means of expensive and complicated switching apparatus.

The small-candle-power alternating-current arc lamps for parallel operation should preferably be operated directly from the regular commercial 118-volt alternating-current mains, as in the case of the direct-current lamp. It is also possible to operate the alternating-current lamps from separate transformers, each having one primary terminal connected to one of the commercial primary wires and the other primary terminal connected to a special wire extending back to the power house or sub-station to a switch which is connected to the opposite side of the commercial primary system, thus providing means for switching the street lamps on and off at the station.

There is a limit to the number of multiple lamps that can be switched on at one time, depending upon the capacity of the generators and primary conductors. It must be remembered that a multiple arc lamp introduces a momentary short-circuit on the line when it is cut in, and the "flush" of current will in most cases exceed the normal current by at least 75 per cent. The normal operating power factor of a small-candle-power alternating-current multiple arc lamp is about 65 per cent, but when the lamp is first switched on, and while establishing its arc, the power factor may be as low as 20 per cent, or even 10 per cent. The effect of switching on a large number of alternating-current multiple arc lamps at one time would thus be to upset the regulation of the entire system, the heavy drop in potential would prevent the lamps from establishing their arcs and the lamp mechanisms would chatter and soon be destroyed.

Small-candle-power multiple arc lamps for alternating-current 118-volt service should be wound for 4 amperes and adjusted for 72 volts at the arc. The apparent watts required by such a lamp would be 472, and with a 65 per cent power factor the actual watts at the terminals would be 306. Assuming the arc to operate at 72 volts with a 93 per cent power factor, the actual watts at the arc will be 267.8. The efficiency at the terminals of this lamp will be about 87.5 per cent on 60 cycles and somewhat higher on higher frequencies.

The average loss in the feeders, mains and transformers for the alternating-current distribution system would run up to about 15 per cent; consequently, the efficiency of the entire alternating-current multiple arc lighting system at the power house bus-bars would be about 74.4 per cent.

Comparing the direct-current and alternating-current multiple enclosed-arc lighting systems, their respective values will be practically as stated in Table I.

TABLE I.

For each multiple arc lamp.	D.C.	A.C. 60 cy.
Voltage at arc	85	72
Voltage at lamp terminals	118	118
Amperes	3	4
Power factor of arc		93%
Power factor at lamp terminals		65%
Actual watts at arc	255	267
Apparent watts at arc	255	288
Actual watts at lamp terminals	354	306
Apparent watts at lamp terminals	354	472
Efficiency at lamp terminals	72%	87.5%
Efficiency at bus-bars in power house	64.8%	74.4%
Required watt capacity for generator and cables	390	542
Required watt capacity for transformers		542

The above table indicates that the efficiency of the alternating-current equipment is about 10 per cent greater than that for the direct-current system, but the alternating-current system requires the installation of about one-third more capacity in generators and distribution equipment, as well as the whole transformer equipment that is devoted to the arc lighting.

As previously stated, small-candle-power arc lamps can also be operated in series. For direct-current series arc lighting, large motor-driven multi-circuit arc dynamos can be obtained which will supply current at about 3.5 amperes to two circuits each containing 50 series enclosed-arc lamps. The full-load efficiency of such generators is about 85 per cent. The efficiency of the distribution system, using about No. 6 B. & S. wire, would not be less than 95 per cent. The small-candle-power arc lamp for this system should be of the differential type and should be wound for 3.5 amperes and adjusted for 75 volts at the arc. Such a lamp would require about 78 volts at the terminals, which at 3.5 amperes represents 273 watts. The shunt coils on the lamp would divert about 1-10 ampere, leaving 3.4 amperes at the arc, which at 75 volts would represent 255 watts. The commercial efficiency of this lamp is thus 93.4 per cent. This system is nothing more than the old constant-current arc lighting system with low amperage, improved generators and modern small-candle-power enclosed-arc lamps substituted for the old-style generators and open-arc lamps. Considering this arc lighting system as described, the efficiency at the bus-bars in the power house would be 75.4 per cent.

The series system of arc lighting permits the gradual starting of the entire circuit of arc lamps, without an excessive flush of current, from the generating station. The series alternating constant-current lighting system with small-candle-power enclosed-arc lamps is the latest development in street lighting and has attracted widespread attention. Such a system can be operated from any ordinary constant-potential alternating source of supply without interfering in the least with the commercial lighting which may be operated from the same source. It is customary to connect the constant-current arc-lighting transformers or regulators directly to the primary bus-bars. To the transformers or the regulators the regular series arc lamp circuit is connected, and series alternating enclosed-arc lamps are cut in the circuit wherever required.

For a small-candle-power series alternating-current arc lighting system, constant-current transformers or regulators can be furnished to deliver 4 amperes and to supply 100 lamps in one or two circuits, depending upon the style of apparatus used. The average commercial efficiency of modern arc-light transformers at full load can be depended upon to be about 96 per cent, and the current regulation is usually within 1-10 ampere from practically no load to full load. The efficiency of the distributing circuit would not be less than 95 per cent.

The series alternating-current arc lamp can be of either the differential or the shunt type. The differential type of lamp has been generally adopted as the standard for series alternating-current work on account of its being better adapted to circuits carrying a large number of lamps operated at high potential. The shunt lamp has been used on circuits including 100 lamps in series, but as the types of shunt lamp used up to the present time require not less than the full-load energy when a circuit is to be started, the sudden "flush" of current is objectionable. The shunt lamp is more efficient and in some respects more flexible, but notwithstanding this, the differential type predominates and will be the only one considered in the present discussion of this system.

The small-candle-power arc lamp for the series alternating-current system is wound for 4 amperes, and with 82 volts at the terminals it requires 328 apparent watts. The power factor of the lamp is about 85 per cent, and the actual power required at the terminals is therefore 278 watts. The arc is adjusted for 75 volts and operates at a power factor of 93 per cent, making the actual watts at the arc 265. The commercial efficiency of this lamp at 60 cycles is 95.3 per cent at the terminals. The efficiency of the complete system, as described, taken at the constant-potential bus-bars in the power house or substation, would be 86.9 per cent.

Table II gives the comparative values for direct-current and alternating-current series arc lighting systems

TABLE II.—Comparison of Direct and Alternating Series Systems.

	D.C.	A.C. 60 cy.
Voltage at each arc	75	75
Voltage at lamp terminals	78	82
Amperes	3.5	4
Power factor of arc		93%
Power factor at lamp terminals .		85%
Actual watts at arc	255	265
Apparent watts at arc	255	285
Actual watts at lamp terminals.	273	278
Apparent watts at lamp terminals	273	328
Efficiency at lamp terminals ...	93.4%	95.3%
Efficiency at bus-bars in power house	75.4%	86.9%
Required watts capacity for generator and lines	340	356
Required watts capacity for transformers		356

This table shows that from an operating standpoint the series alternating system is more efficient than the direct-current series system and that the two systems require about the same capacity in generating and conductor equipment. The series systems, of course, permit the cutting in and out of any circuit of the system, at any time, from the station where the generators or transformers are located. These systems are therefore particularly well adapted to city street lighting where the arc lamps are scattered over a large territory.

Considering the systems as described, Table III indicates that from the central station operator's point of view their respective value is as follows: First, the series alternating-current system; second, the series direct-current system; third, the multiple alternating-current system; fourth, the multiple direct-current system. The cost of maintenance and repair is about the same for all systems, excepting that, as already mentioned, the multiple alternating-current and direct-current systems require special means for cutting lamps in and out which involves a considerable investment or expense for labor. Local conditions may, of course, be such that the multiple direct-current arc lamp could be installed and operated at the same expense as the alternating-current series arc lamp, but as a general proposition this is impossible and where new installations of any magnitude are to be made, either the series alternating or series direct-current system is unquestionably the most suitable, as considered from an operating standpoint.

TABLE III.—Comparison of all Systems.

	D.C. Multiple	A.C. Multiple.	D.C. Series.	A.C. Series.
Actual watts at each arc	255	288	255	285
Power factor at bus-bars		62%		72%
Efficiency at lamp terminals	72%	87.5%	93.4%	95.3%
Efficiency at station bus-bars	64.8%	74.4%	75.4%	86.9%
Watts capacity of generator and line equipment ..	390	542	340	356
Watts capacity of transformers		542		356

As the small-candle-power arc lighting systems described are for city street lighting, their comparative value from the standpoint of the public must also be considered. Taking all details into account, it is safe to state that the direct-current multiple lamp will best meet the demands of the public, because its light is "white" and it is a low-tension lamp, thus making unnecessary high-tension cables, wires and apparatus. The direct-current series system would be the next best on account of its "white" light and the simplicity of wiring and distribution.

The series alternating-current and the multiple alternating-current arc lamps would come next, with practically no choice between them as to their light-giving qualities, but the alternating-current series system would be preferable on account of the simple overhead construction possible with that system.

Considering the small-candle-power arc lighting system for street lighting from all standpoints, the direct-current series system is commercially the most efficient. After this would come the series alternating-current system, which possesses a higher operating efficiency but a somewhat lower commercial efficiency on account of the large proportion of violet rays emitted by the arc; these have a low illuminating value and thus lower the usefulness of this lamp. The direct-current multiple system shows the next best commercial efficiency, but is quite expensive to install if the lamps are scattered over a large territory, as is also the multiple alternating-current system.

For normal street lighting with small-candle-power arc lamps, the distance between direct-current lamps should be about 150 feet in business districts and 200 to 300 feet in residence sections; with alternating-current lamps, these distances should be about 125 feet and 175 to 250 feet respectively. For the business district, lamps should be located on both sides of the street, but in the residence section lamps should preferably be hung near the center of the street. All small-candle-power arc lamps for city lighting should be hung not less than 15 feet nor more than 25 feet above the street and should be equipped with large reflectors if the reflective quality of buildings and surroundings objects is not high.

In conclusion it may be stated that either the direct-current or the alternating-current series arc-lighting system may be successful under conditions outlined above, but in the event of the production of a satisfactory rectifier the direct-current series arc-lighting system would have a great advantage for street lighting

The New Sub-Station at Helena, Montana

In the fall of 1902 the Helena Light and Traction Company, of Helena, Mont., suffered the loss of almost its entire station which supplied the city of Helena with electric power and light. This station was merely a sub-station operated from the Canyon Ferry plant of the Missouri River Power Company. Some remarkably quick work was done in erecting a temporary plant immediately after the burning of the old power house. Plans for a permanent sub-station to replace the one burned were then drawn up, and the results of the work are shown in the accompanying engravings.

Helena enjoys the distinction of being one of the few cities in the United States which depends entirely for its electric railway power and light on a sub-station operated from a water power plant over a long distance transmission line. The majority of the plants so situated have steam power auxiliaries, but in this case, full dependence is placed on transmitted power. The old sub-station was some distance from the center of the city, having been originally a steam plant, and located where it could easily obtain coal. The new station is built in the heart of the city. The building is 50 ft. x 84 ft., one story in height, as shown in both of the interior views herewith. The height from the peak of the roof to the floor is thirty feet, and the height of the traveling crane twenty-four feet. The roof is of iron trusses and purlins and is covered with expanded metal embedded in eight inches of cinder concrete and covered with No. 18 corrugated steel.

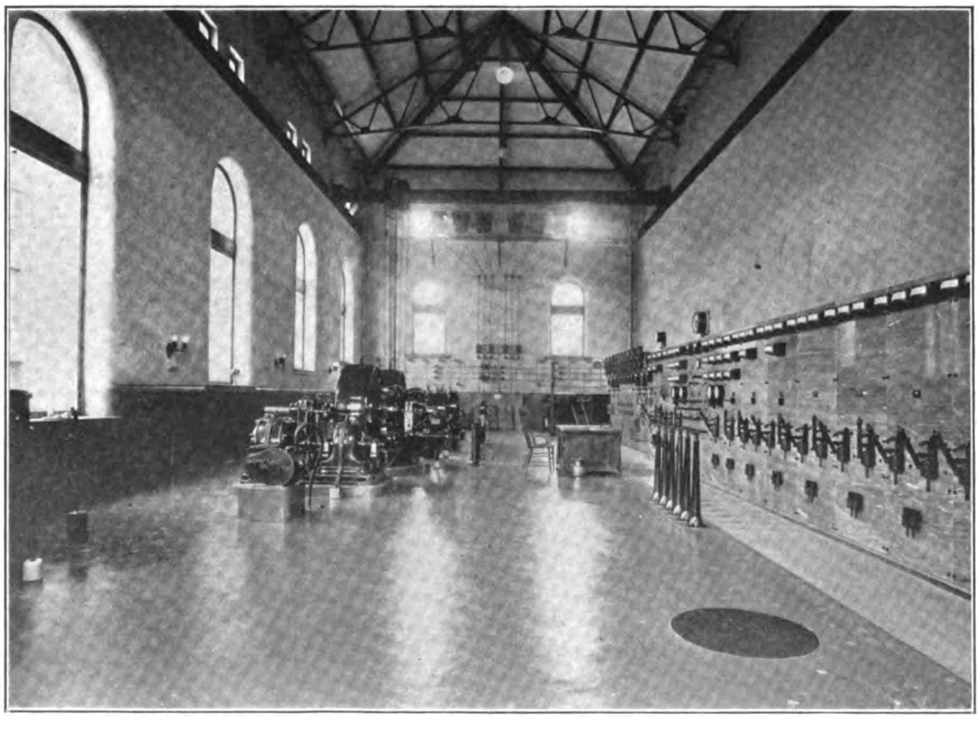


FIG. 1.—INTERIOR OF HELENA SUB-STATION.

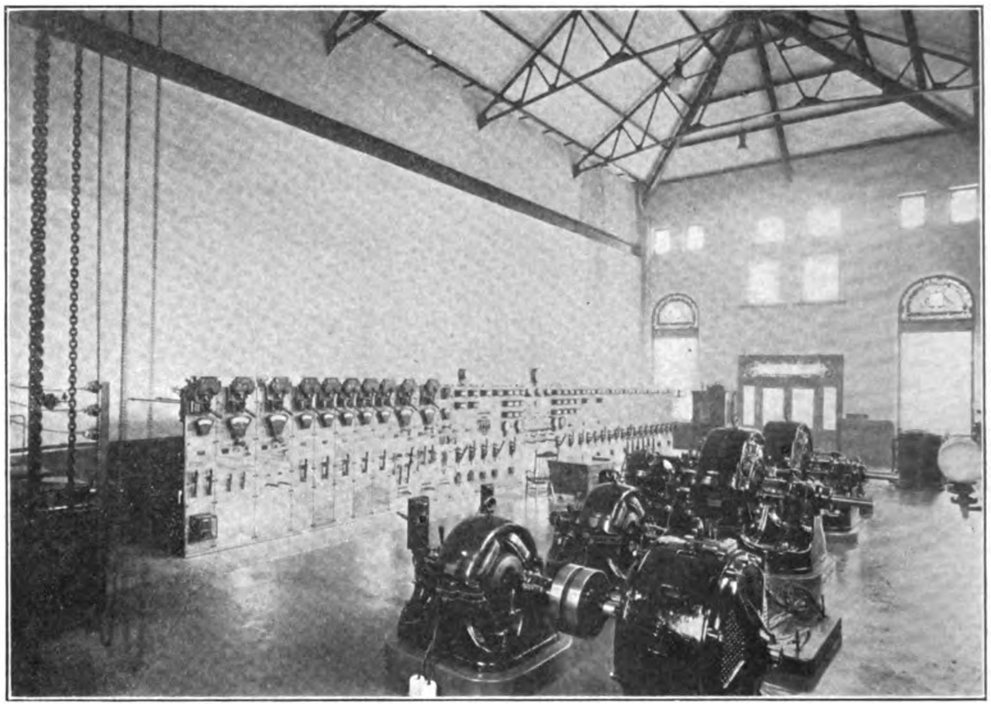


FIG. 2.—INTERIOR OF HELENA SUB-STATION.

There is but one room in the sub-station, which is well lighted, ventilated and floored with concrete. In this concrete floor bituminized fibre conduit is embedded and carries wires from the switchboard and machinery to the subway. This subway extends the length of the building at the rear of the switchboard, and from the center of the switchboard to a point between the rotary transformers.

Externally the building is simple and effective in design. It is faced with porphory (a variety of lava with a light pink tint and extremely hard) and relieved with cut stone trimmings. The main entrance has a well proportioned and finely detailed cut stone porch with columns of pink polished granite. The lower windows are of plate glass; the transoms in front are of art glass, while the windows below the main cornice are of prismatic glass. The building is both substantial and fire-proof. The architectural plans were prepared under the direction of R. A. Willson, superintendent of the company. In the rear of the room are nine Westinghouse step down transformers; three of these, or one bank, are of 450 kilowatt capacity, and are wound with 11,000-volts primary coils and 363-volts secondary coils. These supply current for two 175-kw. Westinghouse rotary converters, two 75-kw. motor generator sets, and three Hartford tub transformers; the latter supplying the series alternating arc circuits. The other six transformers are wound with 11,000-volt primary coils and 2200-volt secondary coils. Three of these transformers are of 175 kilowatt and three are of 450 kilowatt capacity. They supply current for lighting purposes over the city distributing 2200-volt alternating current. The 11,000-volt high-tension current from the Missouri River power plant, eighteen miles distant, enters the building above the transformers on two 3-phase lines. These incoming lines are equipped with choke coils, lightning arresters and G. E. oil switches with automatic trips. They are arranged so as to permit the use of one or both lines either singly or in parallel. Besides the oil switches, each wire is provided with a long fuse switch mounted on high tension insulators.

The lighting transformers are provided with seventeen secondary taps and a potential regulator face plate giving a range of 400-volts regulation on secondaries. The switchboard consists of 29 panels with subbases. Eight three-phase panels with G. E. type M. R. regulators permit of 5 per cent variation in voltage each way. There are two total load panels for incandescent lighting, three Hartford arc panels, one total panel for the 363-volt transformers, four motor generator panels, two for alternating current and two for the direct current; four rotary converter panels, two alternating and two direct; one exciter panel; five 600-volt railway feeder panels, and one panel for a 600-volt non-grounded power circuit. The total panels are equipped with indicating and recording voltmeters, wattmeters and ammeters and also power factor and frequency indicators. The ammeters are connected to the delta or step-down transformers. On each arc panel is an ammeter and an electrostatic voltmeter, reading in hundreds of volts, which can be plugged across any of the circuits or from any wire to the ground. The incandescent three-phase feeder panels are equipped with ammeters, voltmeters and double throw G. E. automatic oil switches. At the end of the board connected to the bus-bars is a static three-phase ground detector. At the rear of the board are two sets of three-phase bus-bars temporarily connected together so that by throwing switches the position of the load can be changed on the phases, making it possible to get two positions for each circuit in balancing. The extra busses are installed for future use.

The switchboard was manufactured by the General Electric Company from a new grade or dark blue Vermont marble, styled Class B1, which is much darker and more mottled than any of the standard marble heretofore used by that company.

The direct-current equipment consists of two Westinghouse, 60-cycle rotary transformers of 175 kilowatts each; two 75-kw. Westinghouse motor-generator sets, one 11½-kw. motor generator exciter, and a Westinghouse air-compressor for cleaning purposes. The rotary-transformers and motors were those formerly used in the old sub-station; but rebuilt by the Helena Light and Traction Company at its repair shop. The exciter set is used in connection with the rotary-transformers during electrical storms, to retain a permanent field on the machinery, when working in parallel.

The direct current bus-bars are so arranged with bus-bar switches that any combination of units can be made between the metallic power circuit and grounded railway circuits. The station is equipped with a Pawling & Harnishfeger traveling crane. All outgoing wires lead from a subway, through tile ducts built in the wall, to a steel tower constructed on top of the building. Provision has been made to put in extra transformers for power and lighting when required; also additional transformers for arc lighting. For these, ducts have been provided in the concrete floor. The company is now operating 25,000 16 candle-power lamps, 250 arc lights, 300 horse-power in stationary motors, and 17 street cars.

CURVE DRAWING OR GRAPHIC RECORDING INSTRUMENTS.

BY H. W. YOUNG.

The importance of using curve drawing, or, graphic recording, instruments, has not, until within a few years, been fully appreciated by many users of electrical apparatus, but, as the art advances, this form of instrument is receiving more and closer attention.

On incandescent lighting systems the curve-drawing voltmeter is particularly valuable, since by its use a continuous record of the line potential may be obtained, and the life and candle-power of an incandescent lamp are vitally dependent upon the pressure maintained at the lamp terminals; a rise in voltage materially shortens the life, while a decrease greatly lowers the candle-power, as is well-known.

Unless a curve-drawing voltmeter is installed, large fluctuations may be known to exist, but no record is made, except, possibly, that obtained from half-hourly readings of the station voltmeter. Of momentary fluctuations, or for the periods between the half-hourly readings, no record whatever is obtained, and between these readings may occur fluctuations of the greatest importance to the system's efficiency.

Voltage fluctuations, like many other evils, may be known to exist, but, unless continuously brought to one's notice, are apt to receive little or no attention. If, on the other hand, the existence of a known evil is continually brought to one's attention, it is very likely to receive serious consideration. A curve-drawing voltmeter may be regarded as a chronic fault-finder with poor voltage regulation, and a faithful recorder of properly maintained pressure. It is also a constant check on the apparatus, operating conditions and employees of a station. If the former is faulty, the conditions too exacting or the employees negligent, the record at the end of the day will indicate it. The manager is thus in a position where he is not obliged to accept anyone's word as to the pressure maintained during the day, and can at once see when and where the system needs his personal attention.

Conditions peculiar to any particular period of day or load are thus brought to light. The exact time is recorded of mishaps to the system, and the hours of starting up and shutting down definitely fixed. Curve-drawing voltmeters can be installed in the office or residence of the manager, and the knowledge of this fact will tend to increase the general watchfulness of the station men and thereby improve the service.

The curve-drawing ammeter is second only in importance to the voltmeter, and is of equal importance where constant current must be maintained, such as on series incandescent or arc lamp systems.

With the rapid introduction of alternating-current power transmission systems, the curve-drawing wattmeter has attained a position of much importance in the electrical instrument field. Such wattmeters are made in both single-phase and polyphase types, and are usually very similar in general appearance to the voltmeters and ammeters. The single-phase instrument, as its name implies, is designed primarily for use on single-phase circuits, although the power of polyphase circuits can be measured, of course, with a single-phase meter by regarding each phase as a separate circuit. The polyphase instrument records the entire energy of the system on a single chart, and, if properly designed, may be used on systems of any power factor and under any degree of unbalancing. The curve-drawing wattmeter furnishes a record of the station's load factor, and by its use the station manager can at once determine the periods of light and heavy loads. With this information he can often adjust the conditions so that more economical operation can be accomplished. These instruments are also extremely useful in determining the load on feeders or other apparatus, and in adjusting the rate of charge per kilowatt-hour.

As station managers begin to realize the importance of having complete station records, the use of the curve-drawing type of instrument will rapidly increase, and result in a general betterment of station operation.

In order that instrument users may have a better understanding of the essential characteristics necessary to the satisfactory operation of the curve-drawing type of measuring instrument, the writer has deemed it advisable to consider at some length the various features which must be taken into consideration. A few years ago the users of this type of instrument were demanding a device which would give a record on a chart, and were not so much concerned about the degree of initial or subsequent accuracy. However, electrical engineering has steadily progressed in every field, and conditions which were allowable a few years ago are not tolerated to-day. The instrument designer has kept pace with these changing conditions, and electrical instruments of all types have been simplified, improved and brought to a degree of excellence comparable with other branches of the art. The curve-drawing instrument has, however, on account of the exacting operating conditions, been one of the most difficult devices to perfect, and a study of the essentials of a satisfactory instrument will be of interest.

In order to insure initial and continued accuracy, the mechanical construction must be simple, robust, and one not easily thrown out of alignment. It is obvious that a complicated or delicate mechanical structure, while possibly satisfactory for laboratory service, would not stand the rough usage to which commercial instruments are subjected during transportation, in course of installation or when in service. The mechanism must be so disposed that all necessary adjustments can be made easily. The facilities for inking the pen, inserting and removing records, winding the driving clock, etc., must be simple and efficient, in order that the instruments can safely be placed in the hands of inexperienced persons.

Measuring instruments, like all other comparatively delicate mechanisms, are more or less fallible, and it is to be expected that ocsional adjustments and repairs will be found necessary. The various parts liable to failure should be interchangeable, as far as possible, so that any necessary repairs can easily be made with the minimum expenditure of time and money.

The Suspension.—One of the most important mechanical details is the proper suspension of the various moving parts. Imperfect or poorly designed bearings introduce serious errors which will increase with service, this latter fact being particularly true if the torque or directive force of the instrument is low. Two principal forms of support or suspension have been generally used, either of which will give good satisfaction under proper conditions. A form of bearing used to a large extent in measuring instruments is the jewel step and pivot bearing. The "step" or jewel consists of a sapphire V-shaped bearing, highly polished, and of extreme hardness. The pivot is made of finely drawn, high grade steel rod, sharpened to a needle point, made glass hard and highly polished. This form of support, when properly made is capable of giving long and continued service, and, if the pivot and jewel are removable, it is easy of repair and renewal. However, great care must be exercised in the selection of the sapphire to make sure that it is free from flaws or soft spots, for, if these conditions exist the pivot will soon roughen the jewel surface, and thus introduce friction which will continually increase.

Knife-edge suspension has been employed to some extent, with very good results, and, in many respects is preferable to the jewel step support. If, however, the knife-edge bearings are suspended by means of the controlling springs, the entire structure is liable to derangement due to buckling or dislocation of the supports. This arrangement is further handicapped by the fact that the controlling spring must necessarily be very weak, in order not to exert too strong a restraining force, and consequently offers a somewhat unstable support for the knife-edges. In places subject to heavy vibration, this unstable condition will cause the armature and recording pointer to vibrate to an appreciable extent, and tend to blur or blot the chart record.

One of the most satisfactory and promising methods in use is to suspend the upper end of the moving element from a steel wire, and center the lower end by means of a highly polished pivot, accurately centered in a sapphire ring-shaped jewel. Owing to the fact that piano wire is of exceedingly close grain and very permanent, it is generally employed in the suspension of curve drawing instrument armatures, and its high tensile strength makes the chance of breakage very small. This form of suspension is strong, simple and of very long life, and it is as nearly frictionless as possible.

Recording Pen.—The recording pen should be of simple construction, and capable of feeding ink freely and uniformly without blotting or sticking. Several forms of recording pens have been devised, all of which are more or less satisfactory. One of the simpler designs consists of a V-shaped trough with one end drawn to a sharp point, arranged so as to press on the moving chart. This form of pen is very efficient, but exposes a considerable amount of ink to the air, thus promoting excessive evaporation. The pen is also subject to a certain amount of chemical action and corrosion by the ink.

A recording pen free from the trouble to which a metal pen is subject, is made from a small section of glass drawn to a capillary tube. By this construction a very small surface of the ink is exposed to the action of the air, and corrosion is, of course, impossible.

In all curve-drawing instruments it is essential that a constant and uniform pressure be maintained between the recording pen and the chart, in order to obtain a clear and accurate record. Many instruments contain a flat spring support for the recording pen, this support being connected to the moving element. Such a construction necessitates a long springy structure, subject to vibration and tending to continuously vary the pressure between the chart and the pen. A preferable method is to mount the pen on a rigid supporting frame, and control the tension by means of an auxiliary spring or weight. This form of mounting allows a considerable range of adjustment for local conditions and is free from the ink effects of vibration incident to the first method.

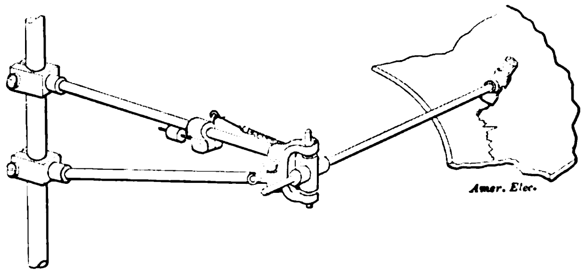


FIG. I.

Fig. 1 illustrates a method of armature suspension and arrangement of recording pen which embodies all of the desirable features outlined in the foregoing paragraphs. The armature is attached to the vertical shaft which in turn is suspended by means of a fine steel wire. The recording pen is made of glass and its support is pivoted in highly polished jewel bearings. This arrangement allows the pen motion to be transmitted in a straight line, a feature of the greatest importance in making records which can be easily read. The pressure of the recording pen on the paper chart is maintained constant by means of a small spiral spring, arranged so that its tension can be easily regulated to suit the local conditions of vibration.

Other Details.—The clock used in curve-drawing instruments for driving the paper chart must be simple, rigid, easily regulated, and an accurate time keeper. Many instruments are provided with a twenty-four-hour clock, which requires attention and winding every day, but whenever possible it is preferable to use an eight-day movement, thus minimizing attention. Hand-wound clocks are invariably employed, as the electrically-wound type has not reached the degree of reliability and simplicity of construction necessary for the satisfactory operation of curve-drawing instruments.

Some mechanical means should be provided for locking the moving parts in position during transportation and installation, for if these parts are unsecured, considerable damage is likely to occur, particularly to the recording pen and suspension bearings.

The electrical, even to a greater extent than the mechanical design, has a vital effect on the curve drawing instruments' accuracy, and this point should receive careful consideration when selecting instruments. Instruments for use on alternating-current circuits must maintain their accuracy under widely varying conditions of frequency, wave form, power factor and external magnetic influences. In order to insure an accurate record under the first three conditions, the various windings and coils must bear correct relations to each other, and not introduce inductive errors.

Effect of External Fields.—Freedom from the influence of stray or external magnetic fields is secured by surrounding the moving coils by a shell or iron casing, thus presenting a path of low reluctance for the stray lines of force. Instruments unprovided with some means of protection are subject to errors of greater or less magnitude due to external fields, and such instruments should be removed as far as possible from cables or bus-bars carrying heavy currents. The shielded type of instrument can, on the contrary, be placed in quite close proximity to such conductors without introducing serious errors, and in this respect are always preferable to the unshielded type.

Torque.—The importance of high torque, as bearing on the life and accuracy of electrical measuring instruments, is not generally appreciated. It is quite possible to produce almost any degree of initial accuracy in such instruments, irrespective of the torque, and this accuracy will continue so long as the initial conditions remain unchanged. However, laboratory and commercial conditions are entirely different, and the fact that a low torque instrument gives excellent laboratory or initial results is no assurance that it will remain accurate when operating under commercial conditions.

The torque of the instrument armature is devoted to two kinds of work, overcoming the coercive force of the controlling or restraining element, and overcoming friction. With a properly designed and constructed restraining element, it may safely be assumed that the coercive factor is of constant value, but friction is always variable, and increases with age and use. An instrument should be so built that the value of the variable factor (friction) should be extremely small in comparison with the constant factor, the restraining force, so that an appreciable increase in the variable work will amount to but a small part of the total work. This condition can only be met in instruments having torque sufficiently high to necessitate a heavy controlling force, as the friction load is then so small in comparison with the torque, that the increase in friction does not materially affect the instruments' accuracy.

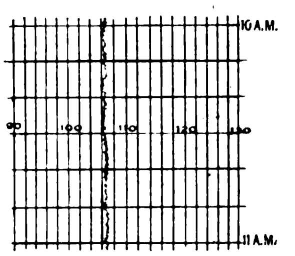
The foregoing holds true to even a greater extent in curve-drawing than indicating instruments, as the friction between pen and chart is added. The effect of low torque on the instruments' accuracy can easily be detected by watching a low torque instrument connected to a slowly varying load. On such a load it will be seen that an appreciable percentage of change in current is required to move the pen from its running position, and when the torque is sufficient to drag the pen away from the point where it has been recording, the momentum carries it beyond the true value, from whence it rebounds, recording a sharp peak which did not actually occur on the circuit. A chart made by such an instrument does not, therefore, represent the changes which actually take place, and may be highly misleading. This sticking of the recording pointer is a common fault in curve-drawing instruments, and can only be remedied by so proportioning the various elements that sufficiently high torque is produced to move the pen to a definite and accurate position instantly upon each change in conditions.

Damping Qualities.—The damping or "dead beat" qualities of all measuring instruments are of much importance, and the proper damping of the armature is of greater importance in a curve-drawing instrument than in almost any other. The damping qualities must be such that the pen will record the actual changes which take place, and not introduce errors by either over-recording or under-recording. If the armature is too heavily damped, its movement will be sluggish, with the result that many of the sudden momentary changes will not be recorded, and the record will appear much more regular than it should. On the other hand, if the damping qualities are not sufficient, the armature will oscillate at each change and the pen will mark sharp peaks in the curve which never occurred on the circuit. It is therefore extremely important that the curve-drawing instrument's movement shall have quick periods, and be perfectly damped, so as to give exactly the right periodicity.

Many methods have been experimented with to produce a suitable damping system, but none have proved so satisfactory as the magnetic form. In the magnetic damping system advantage is taken of the fact that a mass of metal moved across a megnetic field has eddy currents generated within its mass. A sector of sheet aluminum or copper is firmly attached to the armature shaft, and arranged so as to pass between the poles and across the field of either a permanent or an electromagnet. The reaction on the magnetic field by the currents induced in the metal sector causes the movement of the armature to be quickly checked, and brought to rest almost instantly. This method of damping has the advantages of simplicity and reliability, and is free from the objections inherent in liquid or air damping systems.

Liquid damping devices have been used to quite an extent for rendering curve drawing instruments dead-beat, but are far from satisfactory. This form of damper usually consists of a light vane of metal attached to the moving element and playing back and forth in a receptacle filled with oil or glycerine. They are very effective in checking oscillations of the armature and recording pen, but are generally "messy" and objectionable.

Charts.—The charts of curve-drawing instruments must, in order to give satisfaction, be clear, easy of interpolation, and of sufficient size to give at least twenty-four hour runs without renewal. Several forms of chart have been used, each of which has its advantages. A common form is a circular chart which is revolved on its axis in a clockwise or counter-clockwise direction. This chart has the advantage of showing the entire length of record at a time, an arrangement which is often of considerable convenience. However, the circular chart necessitates frequent renewals, as it usually makes a complete revolution in twenty-four hours, and in some instruments in twelve hours. If the chart feed is adjusted so as to run at a higher rate, renewals have to be made at more frequent intervals, in order to prevent the record from overrunning. In order to keep the dimensions of the instrument within reasonable limits, the diameter of the chart is necessarily limited, and this at once limits the scale area and the length of time divisions.



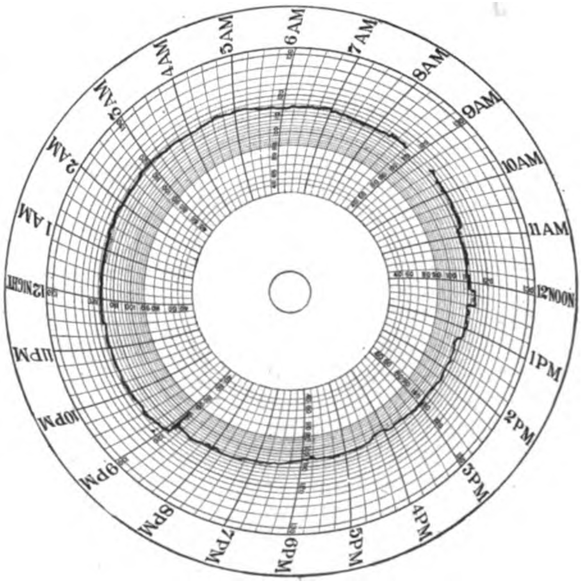


FIG. 2.—BAND AND CIRCULAR FORM OF CHARTS—FIG. 3.

A circular chart also necessitates the use of concentric circles to correspond to the indications of the recording pen, and a set of radial arcs to indicate the time element. The time divisions are, therefore, of unequal area at different parts of the chart scale, diminishing in size as they approach the zero mark on the scale. The use of unequal divisions makes interpolation of the record quite difficult at some points of the scale, and greatly increases the chances of error.

The rate of chart feed must, with the circular chart, be somewhat slow, unless the chart is frequently renewed; the standard rate for the twenty-four hour chart is usually about one inch per hour at the maximum scale reading, five-eights of an inch at the normal and five-sixteenths of an inch at the minimum reading. This slow feed tends to produce a broad blotted record, which shows the maximum and minimum but not the intermediate values, as these have been obliterated by the blotting of the ink.

The circular chart is convenient and useful wherever comparative and broad records are desired, but to obtain the highest accuracy it is preferable to use a fast moving straight-line chart. This form of chart consists of a band of paper approximately 4 ins. wide and from 50 to 75 feet long. In place of the arcs and concentric circles of the circular chart, straight lines are ruled at right angles to each other, the lines running lengthwise of the paper representing volts, amperes or watts, as the case may be, and the horizontal or crosswise lines representing the time element. The time divisions are thus of equal length throughout the entire range of the recording pen, and the diagram on such a chart is perfectly clear and plain. The great length of paper permits the use of a rapid chart feed, a speed of three inches to six inches per hour being practical, and frequently the driving clock is equipped with a set of gears making possible the use of either the minimum or maximum rate of feed. The availability of two chart feeds is often of much convenience, particularly when special tests are to be made. In order to enable the time calibration lines to be drawn at right angles it is necessary that the recording pen be so mounted that its motion is transmitted in a straight line, instead of traveling in an arc. This is accomplished by pivoting the pen and mounting it in jewels at the end of a main arm, attached to the instrument armature, as illustrated in Fig. 1. Figs. 2 and 3 illustrate the relative advantage of the band and circular form charts. The charts are both reproduced to the same scale so that a fair comparison may be made at a glance.

Summing up, it may be said that the curve-drawing instrument must fulfill the following conditions:

(1) The instrument must have high initial accuracy, and must be capable of retaining this accuracy for an indefinite period.

(2) The various parts requiring attention, such as the recording pen and recording chart, must be readily accessible and not liable to derangement.

(3) The dead beat or damping quality must be such that the recording pen will neither overtravel nor undertravel to an appreciable degree.

(4) The record must be clear, easy of interpolation, and of sufficient length per hour to enable the detection of small variations.

(5) The instrument must be easy of installation, compact, and of pleasing appearance.

Abstracts from Foreign Contemporaries

The Regulation of Alternating Current Motors.—The London *Electrician* describes a system for the regulation of asynchronous, alternating or three-phase motors and rotaries brought out by W. Lahmeyer & Company, who propose to regulate the speed of motors by inserting choking coils into the rotor circuit instead of wasteful resistances, as is at present generally the case. It is further suggested to regulate the choking effect by varying the reluctance of the magnetic path of the choking coil. This may be done by more or less saturating this path by a variable number of direct-current ampere-turns. The amount of these may be regulated, either by hand or by automatic means so as to maintain a constant speed of the motor. A purely electrical method of automatically regulating the speed is this: The choking coil, besides being wound with the leads from the rotor, is also wound with two auxiliary coils which oppose each other. One is permanently fed by direct-current from a constant pressure supply while the other receives its current from a small direct-current generator (or from the generator proper in the case of a motor-generator), driven by the motor. If now the motor exceeds its normal speed, the voltage of the auxiliary direct-current generator driven by it will rise, and the magnetizing effect of the bobbin, which is permanently excited, will be opposed to a greater degree than before. The permeability of the magnetic circuit of the choking coil will increase in consequence, and the choking effect will become more pronounced, *i. e.*, the motor speed will decrease, and if the arrangement be properly adjusted the speed will be brought back to its proper value. If the motor speed decreases the reverse actions take place.

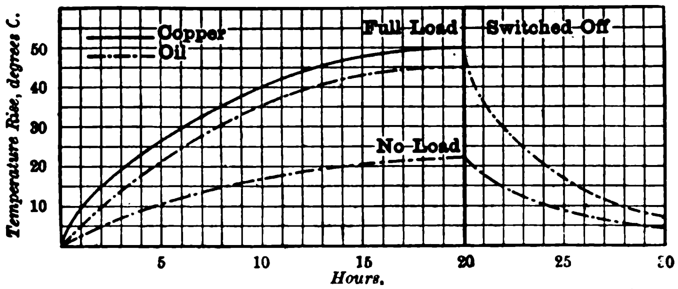


FIG. 2.—TEMPERATURE CURVES OF TRANSFORMER.

Large Oil-Cooled Transformers.—The London *Electrician* describes the oil-cooled transformers built by the Allgemeine Elektricitäts Gesellschaft. These are of the single-phase and three-phase type, and the sizes range from 50 to 500 kilowatts. The core is built up of steel stampings in the manner indicated in Fig. 1, the bolts being insulated to prevent eddy-current losses. Well-ribbed cast iron pieces of the form shown in the illustration are used for firmly clamping together the different parts of the core, the design being such that practically no eddy-currents are set up in them. In the smaller types the low-voltage winding, consisting of a cylindrical bobbin sub-divided into a number of coils, is generally placed next to the core, but in the larger sizes it lies generally on the outside. The radial distance between the high-tension and low-tension windings increases with the voltage. This space is filled in with insulating material. Conductors carrying currents in excess of 100 amperes are sub-divided. Additional cooling-surface is provided for the larger sizes of transformers (from about 150 kilowatts upwards) by flat side tanks, which are connected at the bottom and top to the transformer shell by connections of ample size. The oil in these ribbed side tanks is more rapidly cooled than in the main tank, and, becoming consequently more dense, it sinks and sets up a continuous circulation of oil. Figs. 2 and 3 show the rise of temperature with the time. All connections are brought in through the lid. Strong porcelain insulators are used, and the lower part of them is made to dip into the oil when voltages higher than 10,000 volts are dealt with. Standard voltages are: 10,000, 20,000 and 30,000 volts. The efficiencies at full-load and with unity power-factor are given as ranging from 96.3 per cent for the smallest type designed for a pressure of 30,000 volts up to 98.2 per cent for the 500 kilowatt size built for 10,000 volts. The foregoing figures are based on a frequency of 100 cycles per second and star connection. Both the drop in voltage and the no-load losses of these transformers are small. While the former vary between 1.7 and 0.95 per cent the latter range from 1.8 to 0.9 per cent only.

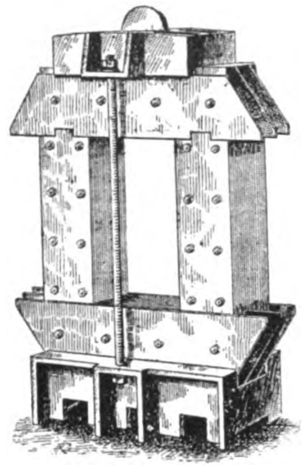


FIG. 1.—TRANSFORMER CORE.

Water Rheostat.—In a paper on the "Equipment of an Engine Testhouse," read before the Birmingham Section of the British Institute of Electrical Engineers, R. K. Morcom says that after considerable trouble and expense in connection with wire resistance, both in wooden and in iron frames, he devised a form of water resistance for taking up the load. The poles are of iron arranged in wooden tanks. Water from a neighboring canal is passed continually through the tanks by a by-pass on the condenser circulating pump, and flows out over a weir. The poles are connected to a load-adjusting switchboard, and can be coupled into the load in many combinations. Three tanks are used for different ranges of voltages, and these ranges are further divided by adjustments of the outflow from the tank. Specially subdivided tanks are used for polyphase work. The first experience when using a water resistance was not very

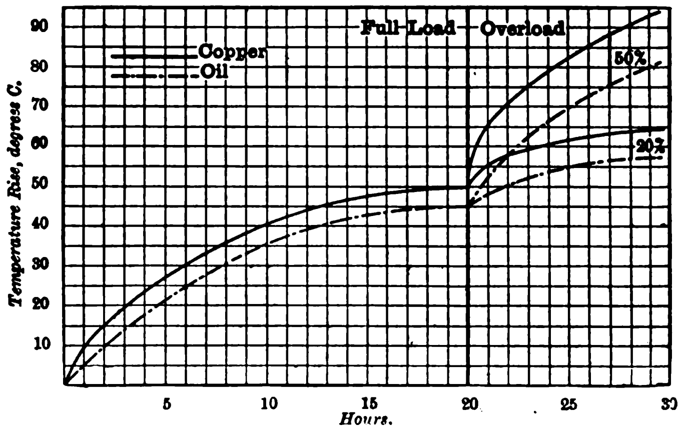


FIG. 3.—FULL LOAD AND OVERLOAD TEMPERATURE CURVES OF TRANSFORMER.

satisfactory. The apparatus consisted of an iron tank about 3 ft. wide and 6 ft. long, with two large iron plates for the electrodes. This tank did not last very long, for the current, as well as passing from plate to plate, found a shorter passage by way of the sides and bottom of the tank. An improvement of this arrangement was a large wooden tank, 4 ft. wide by 10 ft. long, and about 4 feet deep. Into this were fitted four hollow cone-shape castings, large end upwards. Inside each of these cones was a smaller one, suspended from above on a screwed spindle and hand wheel. The outer cone was coupled to one terminal of the dynamo on test, and the inner through a flexible lead to the other terminal. Load could then be varied by raising or lowering the inner cone on the screwed spindle. It was necessary to keep the water level a little higher than the top edge of the outer cone, so that the heated water in the space between the cones might rise naturally and flow away. This arrangement gave very satisfactory results; in fact, some cones are still in use which were fitted about 18 months ago. For higher voltages it was proposed to use a metal rod dipping into the water at the centre of the zone, but the conducting area of water to the outer cone was too large, and the length of water resistance too small for many machines. Accordingly, a wooden trough of small cross section and great length was designed for high-voltage work. The use of wooden troughs did away with the need for conical poles, and it is now found more useful to substitute iron plates fixed at the top to flexible terminals, and movable on insulated rollers along wooden runners. The load can thus be varied by sliding the plates along so that the cross-section between them is varied. By using a considerable number of small plates a very flexible load is obtained, and if care can be taken with the circulating arrangements a very steady load results.

Voltage Drop in Rails With Alternating Current Traction.—Dr. H. Behn-Eschenburg contributes a paper to a recent issue of the *Elektrotechnische Zeitschrift* on voltage drop in rails with alternating current traction, in which he discusses the difficulties which arise from the use of the rails as one conductor in the system, on account of the disturbances set up in telegraph and telephone lines in the neighborhood, using the earth as a return conductor. The Oerlikon Company has made a series of tests on the action of sinusoidal alternating currents of various frequencies on a telegraph relay, a telephone bell and a telephone receiver. The disturbances of telegraph relays and of the electric bell were found to disagree repeatedly with an increase in the frequency from 15 to 50 for a given voltage at the terminals; on the other hand, the vibrations of the telephone membrane will rapidly increase for higher frequencies from 25 to 50 periods. The author concludes that disturbances in telegraph and telephone lines using the earth as return, can only be avoided if the loss of voltage in the railway rails is compensated for. He then describes a system of the Oerlikon Company in which the voltage loss in the earthed rails is avoided by diminishing the current in the rails. For this purpose an auxiliary line is provided which is connected to the rails at regular intervals. Only on that section of the road on which a train is running do the rails carry current. In all other sections the return current does not flow through the rails, but through the auxiliary wire. The advantages of this auxiliary wire, compared with a second insulated return conductor may be questioned, but the enormous simplification of the collection of the current by means of the wheels of the train is of decisive importance. The scheme is shown in Fig. 4, which shows two sections of the road. *L* represents the auxiliary conductor, while *S* represents the rails. Each section contains a transformer, the primary being in the overhead conductor and the secondary in the auxiliary conductor. By properly designing these transformers it is possible to return nearly all of the current through the auxiliary line, while current flows through the rails only in that section on which the car runs. When they applied this method on their experimental lines it was possible to reduce the voltage loss in the rails 25 times. The transformer must be so designed that its self-induction is very large compared with the ohmic resistance of the conductor and the e.m.f. produced must be equal to the voltage drop in the section of the conductor.

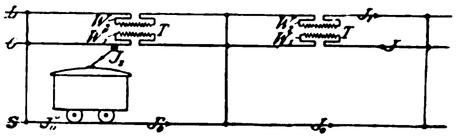


FIG. 4.

Reheater for Steam Turbines.—The accompanying illustration, taken from the *Mechanical Engineer*, shows a method of reheating the working fluid between the stages of expansion in steam turbines, the invention of S. Z. de Ferranti. The arrangement comprises a steam generator 2 having a steam drum 3, the steam being led through the superheater 4 in the uptake. After superheating, the steam divides into two parts, one part going direct to the turbine 5 (indicated by dotted lines as divided into stages) by way of the pipe 6, and the other part passing to the reheaters 7 by way of the pipe 8. In the example illustrated the turbine is provided with five reheaters, the superheated steam from the pipe 8 passing through them in parallel. A pump 9 is provided to return the condensed steam issuing through the pipe 25 from the reheaters to the boiler through the pipe 10, feed-water heater 26, and pipe 27. The steam is conducted from the turbine after the first stage of expansion through the pipe 11 to the bottom of the first reheater, and then upwards in a direction counter to that of the superheated steam, through the coil 12, and back to the turbine. This action is repeated after each stage of expansion in the turbine, the steam finally passing through the exhaust pipe 13 to the regenerator 14. The reheater coils are correctly proportioned to the volume of steam to be dealt with from each stage of the turbine. The steam from the turbine passes through the regenerator to the condenser 19, of the jet condensing type, supplied with cooling water through the pipe 20, and provided with an air pump 21. Another pump, 22, worked off the air pump 21, serves to pass a part of the outflow from the condenser through the regenerator coils 28, whence it passes on and joins the condensed steam from the reheaters. The combined steam may then be pumped through the economizer or feed-water heater 26, placed in the uptake, and returned to the boiler through the pipe 27, thus completing the cycle.

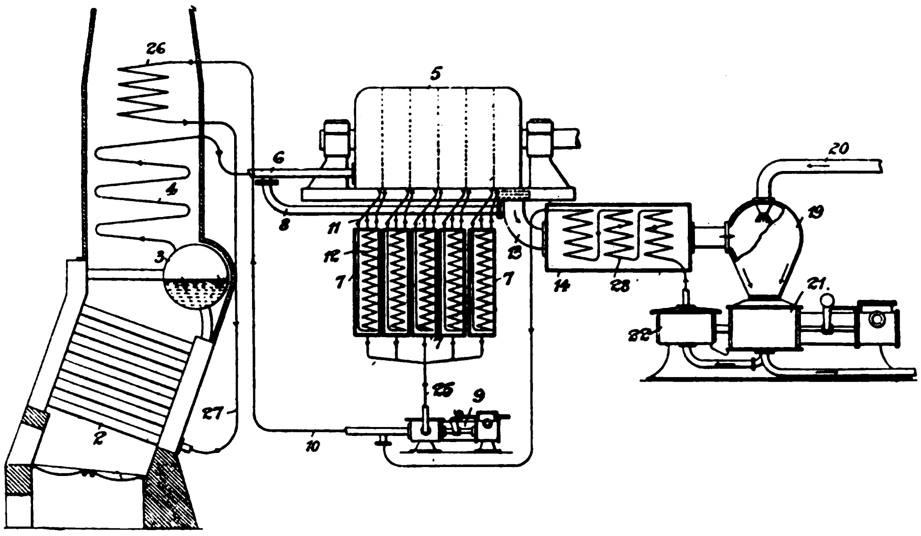


FIG. 5.—REHEATER FOR STEAM TURBINES.

Localizing Faults in Low-tension Network.—If there is one branch of electric light work that is neglected more than any other it is undoubtedly the systematic testing of the lighting mains. For this reason the paper read before the Birmingham Section of the British Institute of Electrical Engineers by W. E. Groves is of timely interest. His remarks refer particularly to a three-wire low-tension network with the neutral earthed at the station through a resistance of 2 ohms. The tests and trials that the author has found convenient are as follows: (*a*) observance of reading of recording ammeter permanently connecting the neutral to earth through a low resistance; (*b*) joint insulation test by Russell method; (*c*) checking polarity of fault by observance of feeder ammeter when "flashed;" (*d*) detection of faulty feeder by "flashing;" (*e*) partial localization by means of "transferring;" (*f*) localization by disconnection of shortest length; (*g*) final localization by induction method. Fig. 6 shows an arrangement of panels for the ready performance of tests (*a*) to (*e*) inclusive. The somewhat elaborate array of neutral switches is necessary to avoid the inadvertent disconnection of a neutral cable when testing.

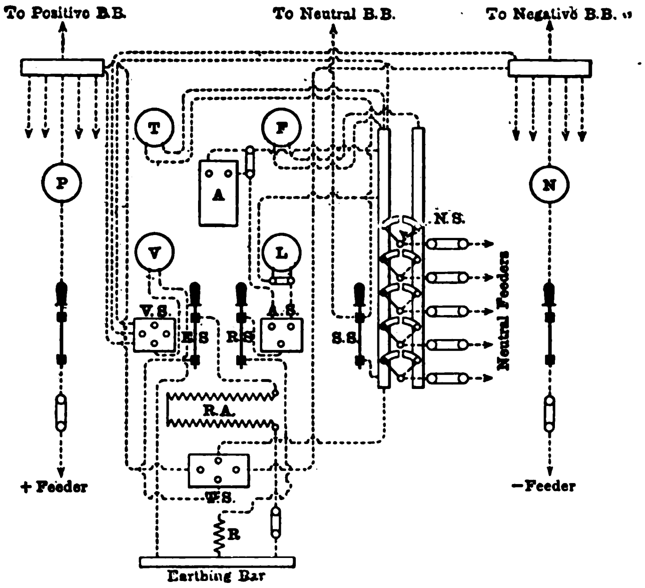


FIG. 6.—DIAGRAM OF CONNECTIONS FOR TESTING.

(*a*) *Recording Ammeter.*—The reading and recording of this instrument shows any alteration in the state of the insulation of the mains, and if this is considerable test (*b*) is necessary. Two qualities render it wholly unreliable as an indicator of the state of the insulation of the mains—its readings are differential and the instrument may be shunted by a neutral fault.

(*b*) *Russell's Test.*—This is most convenient for a rapid and a frequent test. The formula is:

$$F = (V_2 - V'_2) \div c = (V_2 \div c) - R.$$

Referring to Fig. 6, *R* is the resistance in series with the recording ammeter *A*, so that the test resolves itself into the reading of *C* on the ammeter *L* in series with or substituted for *A* at the time of testing, and a momentary opening of the switch *RS* to read V_2 on the voltmeter *V*. For moderately high resistances the value of *R* may be ignored. *V* should be a high-resistance voltmeter. A combined instrument to replace *V* and *L* on the panel is shown in Fig. 12. The object of this instrument is to read *F* directly on an ohm scale when *R S* is momentarily opened.

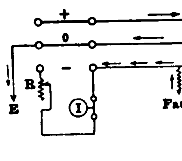


FIG. 7.

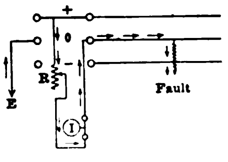


FIG. 8.

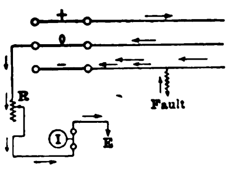


FIG. 9.

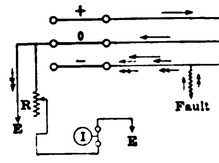


FIG. 10.

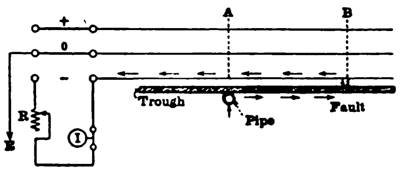


FIG. 11.

It consists of an ammeter and a voltmeter contained in one case. The needles move in two parallel planes and overlap. Between the ampere and volt scales an ohm scale is marked. The scale is plotted for $(V_2 \div c) - R$, the point of intersection of the needles overlying the required readings at *F*. As V_2 and *c* cannot coexist, a special attachment is made to the switch *R S*, which enables the ampere needle to be locked, while the volt needle deflects. An insulating wedge is fixed to the blade of the switch which separates spring contacts when the switch is closed, but when it is slightly pulled forward, and before the "earth circuit" is broken, permits the contacts to come together, thus completing the circuit of a locking magnet, which retains the deflection *c*, after the switch is fully opened and the voltmeter has swung to V_2. The voltmeter and ammeter are entirely independent, and may be used for other tests if required. The voltmeter is provided with a three-way switch, but normally held on the neutral stud by a spring. If the recording ammeter fails to notify any leakage, and the test (*b*) indicates that the insulation is "down," V_2 will be small and *R S* may be left open while the rough tests (*c*) and (*d*) are made. The opening of the switch *R S* avoids heavy local currents *R* and bad sparking at the switches.

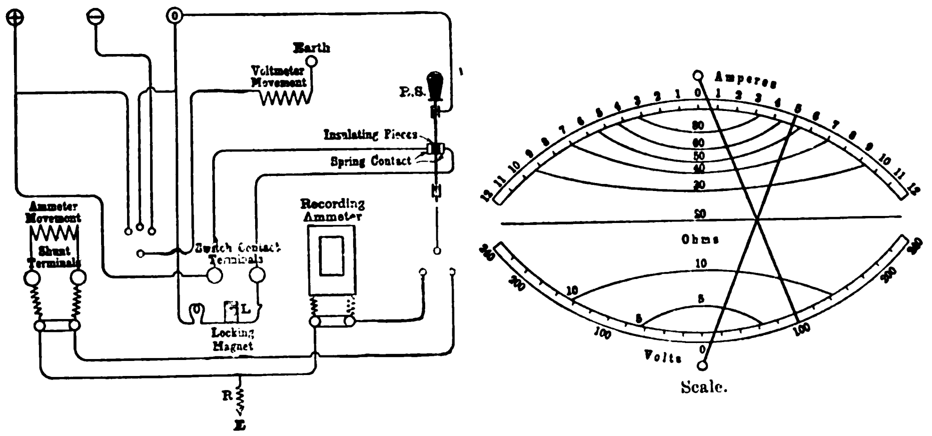


FIG. 12.—DIAGRAM OF CONNECTIONS AND SKETCH DIAGRAM OF SCALE.

(*c*) *Checking Polarity of Fault by "Flashing."*—A central zero ammeter *T* is provided, which can be cut in to take the total neutral current by opening the switch *S S*. Watching this instrument until a fairly steady deflection is shown, either of the outers may be connected to earth through the adjustable resistance *R A* by means of the switches *T S* and *E S*. If the neutral is faulty a "kick" will occur on *T* when *E S* is closed. In the case of a balanced fault the neutral ammeter *T* will be unaffected by this trial, the switch *R S* being open, and the faulty feeder will be indicated by "kicking" of one of the ammeters, *P, N*, on the opposite side of that earthed.

(*d*) *Detection of Faulty Feeder.*—If the last test has proved that the neutral is unsound an ammeter, *F*, may be cut into each feeder separately by means of the switch *N S*, and the last test repeated until the faulty feeder is detected. If considerable fault is shown on *A* the switch *R S* may be momentarily broken while close observation is made of the instruments *P* and *N*. Obviously, a heavy balanced leak is in the nature of a short circuit, and being beyond the control of *R*, makes itself sufficiently apparent on *P* and *N*.

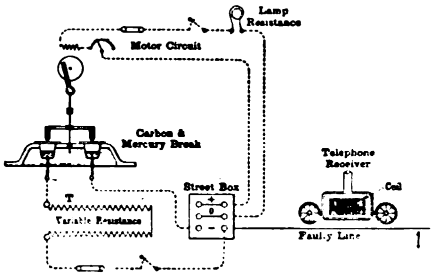


FIG. 13.—INTERRUPTER AND COIL.

(*e*) *Partial Localization by Transference.*—By transferring the distributors from one feeder to another, and momentarily earthing one of the outer wires, if the neutral is faulty, and flashing the switch *R S* if an outer is "down," the fault may be very readily located to the shortest length the arrangement of the network will permit. So far consumers have in no way been interfered with unless operations may have blown the fuse of a faulty internal circuit.

(*f*) *Localization by Disconnection.*—If arrangements can be made for disconnection, tests may be made by means of lamps or instruments. If the fault be on either outer the volts between neutral and earth will be raised. Having connected up the lamp or voltmeter between neutral and earth at the nearest network box, the various lines or services are disconnected until the voltage drops. When the fault is neutral (the earthing switch *R S* at the station being open), an earth connection may be made through a switch and fuse at the junction box where the test is being carried out, the switch being opened after each disconnection until the faulty line is detected by a rise of voltage on an instrument connected between neutral and earth, when the faulty line is cut off. As an alternative to the last trial, a lamp may be connected between either live outer and the faulty neutral, the latter and other outer being disconnected. The faulty line being at or near earth potential, the lamp will glow until the fault is made dead. It is well to make trials at the station before carrying out these rough street tests, in order that the results may be correctly interpreted.

(*g*) *Final Localization by Induction Method.*—The tests described having failed to indicate the exact position of the fault, final localization may be made by means of an interrupter and induction coil. This generally well-known method consists in putting an alternating or interrupted current through the faulty cable, the circuit being completed through earth. A coil, in circuit with which is a telephone receiver, is taken over the route of the faulty cable, starting from the point from which the testing current is supplied. In a successful test, the receiver beats steadily until the point of the fault is reached, when the beat dies away more or less suddenly, owing to the test current going to ground.

The interrupter and coil for fault localization is indicated diagrammatically in Fig. 13. The interrupter consists of a double carbon and mercury break, the carbon-holders being operated directly by the motor spindle by means of an eccentric pin and guide. The motor is run at about 150 r.p.m., and the current (usually about 10 amperes) through the break regulated by the adjustable resistance. The coil is composed of a mile of No. 18 cotton-covered wire wound on a former, through which are placed charcoal iron plates to form a laminated core. The body of the apparatus is supported by two longitudinal beams fitting in grooves in the side of the core, and forming the carriage frame. The wheels have solid rubber tires, and are set wide apart to admit of easy turning. The somewhat cumbersome construction is necessitated by the coil requiring to be as near the road surface as possible. The width of the wheel centres also enables the coil to be run over and along a trench. This is a great convenience if it is necessary to open ground in several places.

Figs. 7 to 11 represent various methods of connecting the interrupter. The small arrows indicate the interrupted earth current, large arrows the supply current, and double-headed arrows the fault current. Fig. 7 represents the simplest case where the faulty line can be disconnected and the interrupter inserted in series with the fault —the fault being on one of the outers. Fig. 8 shows a method of localizing a fault in a neutral. The faulty neutral and one outer are disconnected, and the interrupter connected between the "live" outer and the faulty line. In Fig. 9 the neutral is not "permanently" earthed, or the fault is so bad that the removal of the "permanent" earth connection has no appreciable effect on the pressure between neutral and earth. No interruption of supply is necessary in this case, the pulsating current being superimposed on the supply current. If the coupling is as shown in Fig. 10, no interruption of supply is necessitated, the pulsating current being superimposed on both the supply and the fault current.

When iron ducts are in use or the cables are metal-covered, contact between the ducts or armor and a gas or other metal pipe sometimes leads to false indications, particularly if the soil be dry. The effect is shown in Fig. 11.

SOME RECENT ELECTRICAL PATENTS

Protected Knife Switch.—Figs. 1 and 4 illustrate a protective base for knife-blade switches which has been patented by William McDevitt, of Philadelphia. The base is simply a block of insulating material having deep grooves in its surface and enlarged cavities in the ends; the terminals and switch jaws are located in the larger cavities and the blades and cross-bar lie in the surface grooves when the switch is closed. The object, of course, is to shield the metallic parts of the switch when it is "alive" so that attendants cannot accidentally come into contact with them. Patent No. 757,830.

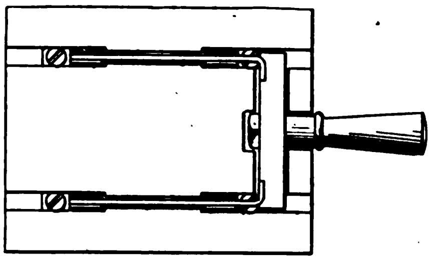


FIG. 1.—PROTECTED KNIFE SWITCH.

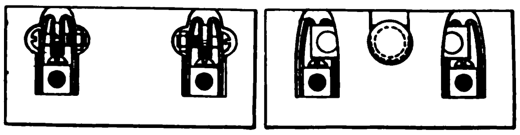


FIG. 2.—PROTECTED KNIFE SWITCH—FIG. 3.

Alternating-Current Motor.—The latest effort to provide a satisfactory alternating-current motor of the commutator type is illustrated by Figs. 5 and 6 herewith, which are taken from a patent issued to Burton McCollum, of Lawrence, Kan. The invention consists in supplying to the field magnet of an ordinary series commutator motor an exciting current lagging behind the main current of the motor by about 90 degrees, and thereby producing a resultant field which lags in time behind the main current. The amount of actual lag is adjustable by adjusting the lag in the superposed exciting current and its strength. The inventor states that he has proved by trial that such motor may be given a power factor of unity, the superposed ampere-turns of the field windings serving to neutralize the self-induction of the armature and main field windings. He does not state what effect his arrangement has upon the torque of the motor; if the field magnetism lags considerably behind the armature current, the torque evidently must suffer considerably. In Fig. 5 the auxiliary field winding is supplied through a transformer and in series with an adjustable reactance, 7; the inventor states that this arangement gave the best results in his tests. Fig. 6 shows the extra winding supplied directly from the mains through the adjustable reactance; the latter is for the purpose of adjusting the lag and strength of the auxiliary field current, of course. Patent No. 759,004.

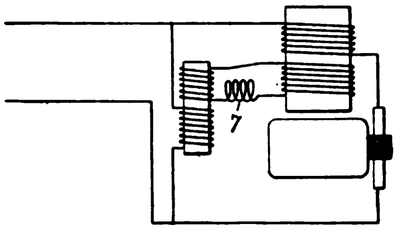


FIG. 5.—ALTERNATING CURRENT MOTOR.

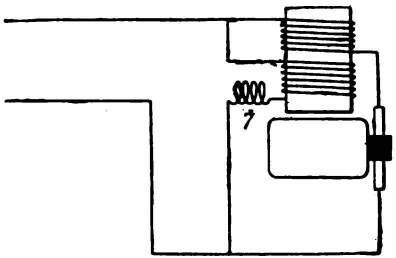


FIG. 6.—ALTERNATING CURRENT MOTOR.

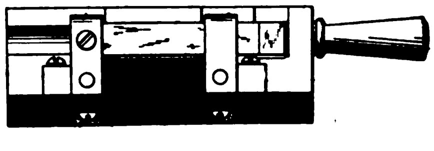


FIG. 4.—PROTECTED KNIFE SWITCH.

Train Lighting System.—It is well understood that in a system of railway train lighting, if the dynamo be driven from a car axle or other source of motion dependent upon the motion of the train itself, means must be provided whereby the dynamo shall deliver current at practically constant potential regardless of the train speed and in the same direction to the storage battery regardless of the train's direction, a battery being invariably provided in systems of the class mentioned for the purpose of furnishing current when the train is stationary or moving at too slow a speed to produce the proper e.m.f. at the dynamo. William A. Turbayne, of Buffalo, N. Y., has devised a system in which the foregoing requirements are met by the use of a small auxiliary dynamo driven by the main dynamo, and a small motor-generator set. Fig. 7 is a diagram of the connections as shown in the patent issued to Mr. Turbayne. The auxiliary dynamo, *C*, is driven by the shaft, *a*, which drives the main dynamo, *A*, and it excites the field magnet of the motor *F;* the dynamo, *D*, driven by this motor, excites the field of the main dynamo, while its field and that of the auxiliary dynamo *C* are excited from the storage battery. The motor, *F*, is worked at low magnetic densities in its iron parts so that its speed is substantially proportional inversely to the e.m.f delivered by the dynamo *C*, and this e.m.f. is directly proportional to the speed of the dynamos, *A* and *C*. When this speed is sufficient to enable the dynamo *A* to deliver normal e.m.f. under maximum field excitation, the solenoid switch *I* is closed by the e.m.f. of the dynamo *C*, and connects the motor *F* to the battery. The motor field being excited at minimum working strength from the dynamo *C*, it starts up and runs at maximum speed, causing the dynamo *D* to furnish its maximum e.m.f. to the field of the main dynamo. As the train speed increases, the e.m.f. of the dynamo *C* increases, strengthening the field of the motor *F* and causing it to reduce its speed in proportion to the increase in car speed; this weakens the field of the dynamo *A*, which is also worked below magnetic saturation, and thereby keeps the e.m.f. of that dynamo normal. No means for connecting and disconnecting the dynamo *A* to and from the battery have been shown in the drawing, but it is obvious that some form of automatic switch would be necessary to disconnect the dynamo leads when its speed falls so low that current begins to flow backward from the battery through the dynamo armature. Reversal of the train direction reverses the direction of rotation at the dynamo shaft, *a*, of course; as the field of the small dynamo *C* is excited always in the same direction from the battery, this reversal of speed reverses its e.m.f.; consequently the motor *F* is reversed, causing its dynamo *D* to excite the field of the main dynamo in the opposite direction, and the e.m.f. delivered by the latter is therefore in the same direction as before its rotation was reversed. Patent No. 757,695.

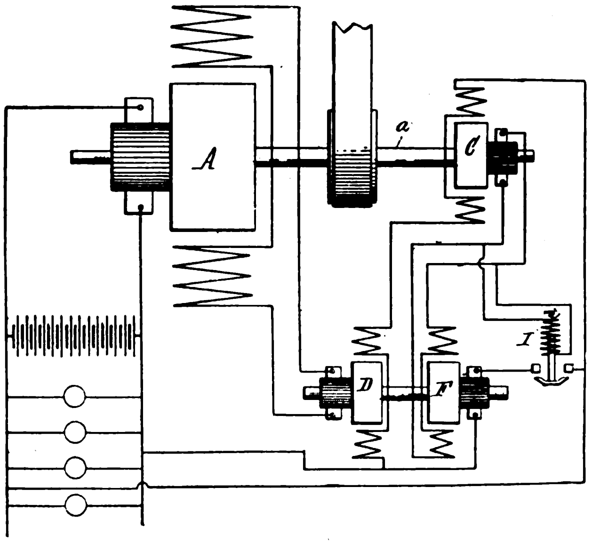


FIG. 7.—TRAIN LIGHTING SYSTEM.

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The Steam Turbine vs. the Reciprocating Engine.

To the Editor of the American Electrician:

Sir:—The writer has read with some interest your article on the steam turbine situation by Mr. A. M. Earl. I do not think that he has stated the situation as the merits of the turbine demand.

From the position of the reciprocating engine man, I can readily appreciate his question of "Where are we at?" And while it is true that the development of the steam engine has covered virtually a period of 125 years, as far as its principle is concerned it is very little different from where it started. The limitations of its evolution are all that he has stated in regard to the limiting steam pressure, superheat, vacuum, rotative speed, piston speed, bearing speed, size of low-pressure cylinder, degree of regulation, pressure on bearing surface, cylinder clearance, and he might have gone on with a long list of others, practically insurmountable barriers from a mechanical standpoint to the perfection of the reciprocating engine. All these elements of trouble have been known almost from the inception of the reciprocating engine, and have been simply endured for the reason that there was nothing better to take its place.

That the turbine does not suffer all these elements of trouble should be a well-known fact to every engineer. Mr. Earl says that the troubles of the steam turbine are something like this: Blades wear and strip, governors get out of order, bearings heat and cut, lack of mechanical balance creates disturbances. He gives no further enumeration, and he has stated there about all the elements that there are in the steam turbine that are liable to give any trouble whatever. Now, referring these same troubles to the reciprocating engine, of course the engine has no blades to wear and strip; but the turbine blades do not wear and strip. The writer believes that the Parsons machine when first put out did give some trouble from its blades stripping out, but this trouble has been practically eliminated and there is practically no chance of the buckets of the Curtis-type turbine stripping out. There is a possibility of wear if wet steam is used and the buckets might possibly have to be replaced after a run of several years, which is very easily done provided they are properly constructed.

Mr. Earl speaks of the governor as a source of trouble, as though such a thing were unknown on a reciprocating engine. The writer is perfectly free to admit that he has seen some engines that he thought would operate very much better if the governor were left off, but the governor on a turbine is a much simpler affair, with less wearing parts and less liability to get out of order than anything that has ever been produced for a reciprocating engine giving any satisfactory degree of regulation.

As to bearing heating and cutting: Bearings will heat and cut if they are not properly lined and given plenty of oil, but there is not the element of danger in the bearings on a turbine that there is on an engine, as the number of bearings is reduced to a minimum and there is nothing but a rotative element to cause heating; with proper lubrication a turbine bearing is one of the last places there is any chance for trouble. Perfect mechanical balance is of course necessary and no maker would be foolish enough to put out a turbine without first securing it. There are several things Mr. Earl left out in referring to the reciprocating engine which are necessarily out of consideration in a turbine, such as the danger of fly-wheels bursting and cylinder heads blowing off due to water getting into the cylinder.

As to the economy of steam turbines as compared to reciprocating engines, Mr. Earl makes an off-hand statement about the meagre reports of machines in actual service, indicating limitations which render it very doubtful if the hopes of the designers will be fully realized. I should be pleased to know if he can point out a single case where the Curtis or Parsons turbines have not fulfilled the guarantees of the makers and are not operating satisfactorily where they have been installed. I do not claim that the steam turbine will replace the reciprocating engine for all purposes, but I do claim, and justly, I believe, that for electrical power stations the steam turbine has no equal where steam power is used. While the economy may not be any greater at full load than the best compound Corliss-valve engines working under ideal conditions, the part load efficiency is so far superior that the economy at full load need hardly enter into consideration. I do not think that there is any engine builder today who would under any conditions guarantee that the steam consumption of a Corliss engine at one-fourth load would not exceed by two pounds per brake horse-power the steam consumption required per horse-power at full load, but this is something that is being guaranteed now on steam turbines built in this city—a result there is no difficulty in obtaining.

Summing up, the steam turbine is ideal in its simplicity, it requires when installed a minimum amount of attention, it takes up a very small amount of floor space per horse-power, its economy at full load is equal to the economy of the best Corliss engine, while its economy at part load is far superior to the same class of engine. I believe that the reciprocating engine for use in connection with electric generators will within the next four or five years be considered absolutely obsolete, and there are a great many cases even now where it is only a question of delivery as to whether people shall put in steam turbines or reciprocating engines.

Sandusky, Ohio. E. C. CROCKER.

NOTES.

Ohio Society of Mechanical, Electrical and Steam Engineers held its eighth annual meeting in Columbus, Ohio, May 13 and 14. The convention was a very successful one, both as to the attendance and the character of papers presented.

Electrical Workers in Boston.—Electrical Workers' Union No. 103 has increased its membership to such an extent as to necessitate the employment of a secretary to devote his entire time to the work. Union No. 104 now has a membership of about 400.

High Tension Transmission.—A special meeting of the American Institute will be held at Chicago, June 21 and 22, for the discussion of high-tension electrical transmission lines. The meeting will be conducted by the Transmission Committee of the Institute, and the subjects discussed will include "Steel vs. Wooden Insulator Pins," "Line Construction with Steel Supporting Structures and Long Spans," "Bare vs. Insulated Conductors for Interior High-Tension Wiring," and "Continuous Service over Lines Operated in Parallel."

The Edison Storage Battery.—At a recent meeting of the New York Electrical Society an interesting lecture was delivered by Mr. R. A. Fliess on the new Edison battery, in the course of which the speaker presented some new data regarding the performance of the Type E cell. A test of this cell showed an output of 272½ watt-hours at 30 amperes discharge rate and 240.6 watt-hours at 120 amperes. The weight of the cell was 47¾ lbs. per horse-power at the lower rate of discharge and 54¼ lbs. per horse-power at the higher rate.

General Electric Annual Report.—This report shows that during the year ended January 31, 1904, the General Electric Company received orders for $39,060,038 worth of apparatus as compared with $39,944,454 for the previous year. The orders included generators, steam turbines and rotary converters aggregating about 900,000 horse-power; railway motors aggregating over 300,000 horse-power; transformers aggregating over 650,000 horse-power, and stationary motors aggregating over 200,000 horse-power. The manufacturing floor space aggregates about 3,700,000 as compared with 3,000,000 square feet at the end of the previous year; the space is still being extended.

John F. Wallace Chief Engineer of Panama Canal Work.—Mr. John Findley Wallace, General Manager of the Illinois Central Railroad, has accepted the position of Chief Engineer to the Panama Canal Commission and will take up the work on June 1. Mr. Wallace will have full charge of the construction of the canal, at a salary of $25,000 a year. In accepting the position he made a considerable financial sacrifice, in the estimation of those who are familiar with his prospects with the Illinois Central. Mr. Wallace is not quite fifty-two years old. He is a graduate of Monmouth University, and has had extensive experience in railroad and bridge engineering. He is a past president of the American Society of Civil Engineers, the American Railway Engineering Association and the Western Society of Engineers, and is a member of several other engineering societies.

The Magnetic Club, of Philadelphia, gave its first dinner recently, and the affair was a tremendous success. The officers of the Club are: S. S. Garwood, president; L. Lemon, first vice-president; John C. Sager, second vice-president; F. W. Griffin, third vice-president; J. P. Altberger, fourth vice-president; C. B. Wood, secretary, and H. W. Hetzel, treasurer. Mr. Frank E. Maize is chairman of the Governing Committee. The dinner was given at Boothby's restaurant, and 175 members and guests were present. Just before the opening speeches, President Garwood arose to introduce Mr. F. W. Jones, president of the New York Magnetic Club, when a huge cluster of roses hanging above his head was released electrically by the pressure of a button in another part of the room and Mr. Garwood found himself covered with flowers. Over the head of the banquet table were grouped incandescent lamps forming the figure "73," the telegraphic symbol meaning "best wishes." At the close of the banquet this device was extinguished by the pressure of a button at President Garwood's right hand and the figures "30" in frosted lamps were lighted; this is the telegraphic symbol for "Good-night." Appropriate addresses were made by Mr. Garwood, who presided and acted as toastmaster; Mr. F. W. Jones, Mr. W. C. L. Eglin, and others. The affair was highly enjoyed by those fortunate enough to be present, among whom were: Messrs. Thos. E. Fleming, of New York; W. S. Westbrook, superintendent Delaware & Atlantic Telephone Company; M. J. O'Leary, New York; W. A. Manwaring, superintendent Arc Lamp Department, Philadelphia Electric Company; T. G. Seixas, vice-president, Germantown Electric Light Company, and W. K. Beard, Philadelphia Manager, AMERICAN ELECTRICIAN.

The Exposition Railway Tests.—A full meeting of the Executive Committee appointed to determine the nature and scope of the electric railway tests to be made at St. Louis and elsewhere during the coming summer was held at St. Louis on Friday and Saturday, May 6 and 7. The committee consists of Prof. W. E. Goldsborough, Chief of the Exposition Department of Electricity, chairman; Prof. H. H. Norris, of Cornell University, and Prof. B. V. Swenson, of the University of Wisconsin, and H. T. Plumb, of Purdue University. The committee decided to undertake series of tests (*a*) on the service capacities of electric motors, (*b*) for acceleration, (*c*) of brakes, and (*d*) on train resistance.

In the tests for service capacity of motors, various equipments will be operated on special tracks at different rates and periods of acceleration, coasting and braking, with different lengths of stops, in order to determine the heating of the motors under conditions approaching as nearly as possible those of commercial practice. The motors will also be tested separately for heating and for the determination of their torque curves and accelerating power. This will render possible the comparison of the performance of the same equipment upon the track and upon the test stand. The acceleration tests will be made on single cars and on multiple unit trains to determine the ability of the equipment to bring the cars up to full speed quickly and economically.

Braking tests with single cars and multiple-unit trains will be conducted in order to determine the quickness of action, the shapes of the braking curves, the relation between the braking forces and the applied pressures and the best methods of application of the braking forces.

In the train resistance tests, determinations of the resistances due to the rails, to the journals and gearing and to the air will be made by a systematic and complete series of runs. In addition to this definite series, a number of other tests will be conducted upon various exhibits in the Palace of Electricity in order to determine the efficiency and reliability of the apparatus.

Sections (*a*), (*b*) and (*c*) of the tests will be carried out on the tracks which have been built for the purpose by the Exposition. These are of substantial construction, conveniently located, and of a total length of about 4500 feet. For the tests described under section (*d*) the Indiana Union Traction Company has provided a stretch of eight miles of straight and heavily ballasted track. The resistance tests will be made after the completion of the St. Louis programme.

In all of the work, graphical records of the measurements will be obtained by the use of autographic instruments which will be either built for the purpose or supplied through the cooperation of the manufacturing and operating companies and the technical colleges. The National Bureau of Standards will materially aid in this work by providing facilities for the calibration of all of the instruments.

The actual work of observation and calculation will be carried on under the personal supervision of the superintendents by a corps of young men carefully selected from among the graduates of leading technical schools, the total number of observers being thirty and forty. The Exposition management is cooperating enthusiastically with the Railway Test Commission in providing ample facilities for the tests, and substantial results of permanent value to the profession are confidently expected.

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NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

Vol. XVI. JUNE, 1904. No. 6

Of this issue of the AMERICAN ELECTRICIAN *20,000 copies are printed. This paper has the largest paid subscription list of any electrical journal in the world.*

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A Remarkable Central Station Record.

The rapid development of the central station service at Kansas City during the past five years, as described by Mr. Barth in our leading article this month, is typical of the growth of the electric lighting business in every city of appreciable size where there has been progressive management; but the growth at Kansas City has been perhaps more rapid and astonishing than that in most other cities of comparable types. The history of the plant's development is well worth careful reading by anyone interested in central station work. The present general manager of the plant, Mr. R. E. Richardson, upon taking charge of the property was confronted with the problem of taking care of the increasing business with a number of old power stations containing almost obsolete apparatus, and at the same time constructing the new station and feeders. His first move was to institute a complete system of records, which he used as a guide in making the necessary improvements. As these records began when the company was operating the old-style machinery five years ago, and have been continued up to the present time, they furnish information which is invaluable as an object lesson in the advantages of substituting modern for old-style apparatus as well as a fine illustration of the smoothness with which such changes may be made under competent supervision. This information Mr. Barth has presented in the most concise style, without resorting to burdensome statistics.

The account of the company's experience during the great flood of last year is also highly instructive, and is, we believe, the first comprehensive one that has been published, from the electrical engineering standpoint. The incidents of the flood are unprecedented in many respects. Cases are on record of electrical apparatus being dried out and put into operation after having been completely flooded, but we think there has never been elsewhere such a wholesale flooding of large and small apparatus in a station of the magnitude of this one. This fact, as well as the comparative ease with which the 6600-volt apparatus was cleansed and dried after having been subjected to such unwholesome contact with water, mud and rubbish of all sorts, must increase one's respect for electrical machinery immensely. Strange as it may seem, greater difficulty was experienced in restoring to a workable condition 500-volt railway generators flooded in other stations last summer than was encountered in drying out the 6600-volt alternators at the Kansas City station. This was due to the presence of the commutators on the direct-current generators. Well-designed machines of this class have such ample commutator capacity that a current that will heat the armature winding almost to the danger point will not raise the temperature of the commutator enough to dry out the mica strips between the segments. In one case that has been brought to our attention, the commutator had to be dried out by means of blow torches after the armature winding had been thoroughly dried out with current.

That the loss of generator and transformer coils was so insignificant in the Kansas City station was due primarily, of course, to the high grade of construction embodied in the manufacture of the apparatus; but it was also due to the care and attention to details in the drying-out process. And when one considers that the work of drying out was necessarily hurried as much as possible, the results are still more remarkable.

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Small Candle Power Arcs for Street Lighting.

For the problem of street lighting in the smaller cities and larger towns, there seems to be little reason to doubt that the small-candle-power enclosed-arc lamp furnishes by all odds the best solution; and for service even in cities of considerable magnitude there are many valid arguments in its favor. In another part of this number will be found a very comprehensive discussion of the relative merits of the various small-candle-power systems which cannot fail to be of vital interest just at this time; the author of the article mentioned, Mr. Hallberg, has had exceptional opportunities for investigating the operating value of such lamps and systems, and the article is a thoroughly practical presentation of the subject, based on experience.

The author's deductions as to the relative value of the different small-candle-power arc lighting systems from different standpoints will, we believe, not be seriously questioned by any non-partisan expert. As we stated last month, the alternating-current arc lighting system has the great advantage for large stations of reducing the generating units to a single type, but the engineers of some pretty large plants have chosen the disadvantage of separate direct-current arc lighting dynamos in preference to the disadvantages of the alternating-current arc. We heartily agree with Mr. Hallberg that the production of a thoroughly satisfactory rectifier would put the direct-current arc lamp much ahead of the alternating-current lamp for street lighting—and for most other kinds of service, for that matter.

It would seem, from an "outside" standpoint, that the task of devising a rectifier for changing alternating current of constant amperage to pulsating direct current ought not to be a more difficult one than that of providing a transformer to change constant alternating potential to constant alternating current. Yet the latter was accomplished years ago, while some of the brightest modern engineers have failed to develop a rectifier that is wholly satisfactory commercially.

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The Embryo Electrical Engineer.

One of the most perplexing of all the requests for advice or information that are received at this office is the letter asking us to advise a young man what course to pursue in order to become an electrical engineer, the means for taking a collegiate course not being available; also to suggest the best branch of electrical work. It is, of course, impossible for us to offer much specific advice in such cases; without knowing intimately a young man's natural characteristics, one cannot intelligently suggest what avenue of work would be apt to suit him best, and there is no "best branch" of the electrical industry from any other standpoint. Naturally, we advise taking up a course of study with some correspondence school, if one cannot have the advantage of personal tutelage, and when this is said it exhausts the possibilities in the way of specific advice under the circumstances.

Generally speaking, technical education is absolutely necessary to even mediocre success in any branch of electrical or other technical work; with a given amount of honesty, intelligence and industry, the better the education, the greater the measure of success. By "education" we do not mean necessarily college advantages, valuable though they are; some of the highest grade men in the electrical field are self-educated, and some of the most hopelessly incompetent boast college degrees. With the facilities that now exist for acquiring technical education, there is no excuse whatever for anyone to remain wholly ignorant of fundamental principles and their application. But the road to complete qualification as an electrical engineer is not an easy one, and while there is always "room at the top," there is no room in the class of the poorly qualified—no demand for the mediocre engineer. If one elects to become an electrical engineer, therefore, the standard should be set very high and the aspirant must determine to sacrifice everything except personal character, if need be, to the drudgery of acquiring the necessary mental training and practical experience. These may possibly be acquired simultaneously, but it is usually necessary to obtain the mental training first. Detailed advice as to just what steps to take in order to secure the requisite knowledge and experience is out of the question; a man's resources, environment and restrictions chiefly determine this, and these are seldom combined in the same way twice. Moreover, a man who possesses the personal qualities essential to thorough success does not require to be steered along from point to point in his upward course.

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United States Patents.

The patent situation in this country has long since reached a point where it excites either ribald mirth or mingled disgust and resentment, according to whether one is a spectator or a victim. The actual value of a patent, as is well recognized, is usually nothing until its owner has had it subjected to the expensive judgment of the courts; this is true of at least the large majority of electrical patents, regardless of the intrinsic merits of the inventions or improvements. Moveover, patents are issued which even a layman with fair powers of analysis and access to Patent Office records could easily show to be without justification, and applications are rejected on purely technical grounds when there is no similarity between the subject matter of the invention and that of the invention cited as an anticipation. It would seem to be entirely practical to eliminate the farcical elements just mentioned by the establishment at Washington of a patent tribunal of last resort, which would obviate the necessity for appeal to the regular and usually technically incompetent courts and make it possible to obtain consistent precedents for the guidance of patent examiners; under the present system the courts hand down conflicting rulings without rhyme or reason.

The foregoing features of the patent situation, however, affect practical electrical workers only indirectly. The most serious feature to them is the ease with which worthless patents may be obtained—if one has the necessary cash. This is not the fault of the governmental patent system, any more than the ease with which the unsophisticated can be fleeced by promoters and unscrupulous brokers is the fault of the legal system of a State. Patent attorneys, as a class, are among the most rigidly honorable of professional men, but the list includes also black sheep who do not hesitate to urge a client to take out a patent for an "invention" that they know absolutely to be not worth a solitary dollar on an honest basis. In view of this well-known fact, together with the condition mentioned in the beginning of the preceding paragraph, it behooves the practical worker beset with new ideas to submit those ideas to the critical examination of some one better qualified than he is to judge their merits before rushing off to a patent mill and sacrificing hard-earned money. But if the struggling inventor *will* rely on his own judgment and is determined to have a patent at all hazards, he should at least steer clear of the patent attorneys who boast of never having a claim rejected or guarantee to secure a patent regardless of the character of the invention; no conscientious attorney can claim any such ability.

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The Exhaust Pressure of a Gas Engine.

Almost all of the earlier text books on the gas engine explained the high pressure of the exhaust gases on the ground that the necessity for high compression pressures made it impractical to expand the burning gases below the ruling exhaust pressures, which were then about 30 to 40 pounds above atmospheric pressure. That high compression is necessary to high efficiency is, of course, well recognized, and it is also perfectly well known that the higher the compression pressure, the higher will be the exhaust pressure, other conditions being unchanged. Practical gas engine designers, however, have long ago learned that the requirement of high compression pressure does not necessarily entail high exhaust pressure, because it is not at all necessary, academically, to maintain any particular ratio between the two. A given compression pressure can be obtained with a certain cylinder clearance and a throttled admission that would be obtained with a larger clearance and perfectly free admission, and the exhaust pressure would be much lower in the first case than in the second; but the output of the engine would also be lower. The question of exhaust pressure, therefore, is determined largely by the cost of manufacture, although other considerations enter also. If the weight of the engine per unit of output at a given piston speed could be made anything, regardless of cost, it would be a relatively simple matter to get the exhaust pressure down to a few pounds above the atmosphere. This is clearly indicated, aside from any theoretical consideration, by the changes in the exhaust pressure of a throttling gas engine operating under widely varying loads.

THE CONSTRUCTION OF A TWO-PHASE SYNCHRONIZER.

BY PAUL C. PERCY.

The accompanying drawings and description relate to a two-phase synchronism indicator of the "revolving light" type, similar to the apparatus described in the last number of this paper for three-phase work. In the present case, there are two transformers, as before, but one of these is a two-phase transformer; four incandescent lamps are required instead of three. Such an outfit may be constructed with extremely limited facilities in the way of machinery and tools; the greatest care must be exercised, however, in applying and maintaining the insulation of the transformers.

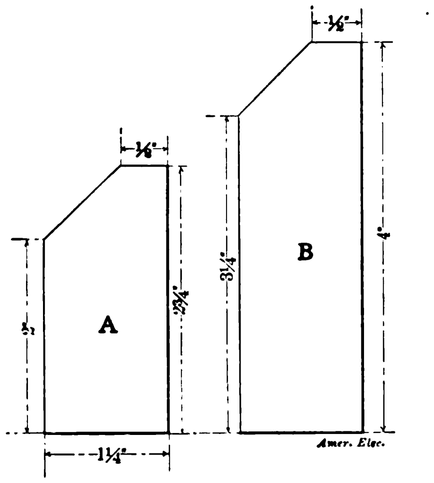


FIG. 1.

The single-phase transformer is built up of rectangular strips of sheet steel each having one corner cut off, as indicated in Fig. 1; there must be two sizes of these strips, as the engraving shows, and of the dimensions specified in the sketch. The thickness of the sheet steel may be 25 mils; this would be too thick for ordinary transformer work, but as these transformers are in circuit only a very short time the increased core loss due to the thick sheets is of no importance.

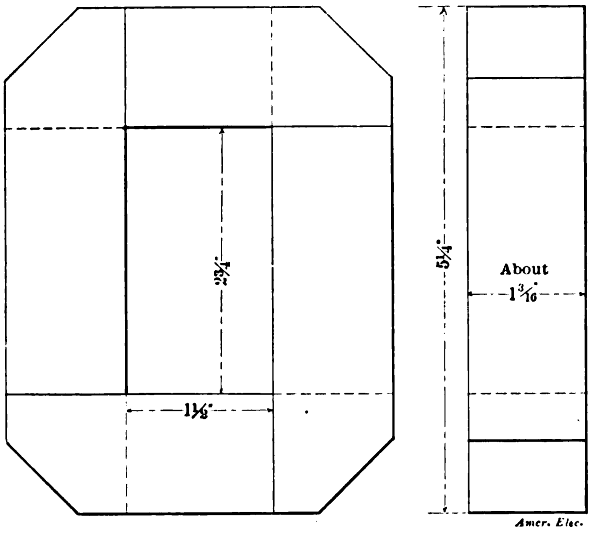


FIG. 2.—COMPLETE CORE OF SINGLE-PHASE TRANSFORMER.

There will be required 80 strips of each size shown by Fig. 1, and these are to be built up to form a core of the shape and dimensions shown in Fig. 2. The core is 40 sheets thick and these 40 sheets should compress to about 1 3-16 inches, as indicated by the dimension stated on the edge view of the core. The strips must be staggered, so as to break joints, the first layer being put down as shown by Fig. 3, the second layer as shown by Fig. 4, the third layer like the first, and so on.

Before the core can be built up, the coils must be wound, taped and baked. The coils are wound in fibre bobbins, the heads of which are made of 1/8-inch hard fibre of the shape and size shown by Fig. 5. Two of these heads are fastened to the tube of the bobbin, one at each end, by means of thick shellac varnish. The tube consists of a sheet of 1-16-inch fibre 2 3/4 inches wide and 5 1/4 inches long, bent into tubular form so as to fit in the square openings in the heads. The bobbin must be mounted on a square wooden mandrel and the heads backed up by blocks tacked on the sides of the mandrel, so that the wire will not press the heads off the ends of the tube.

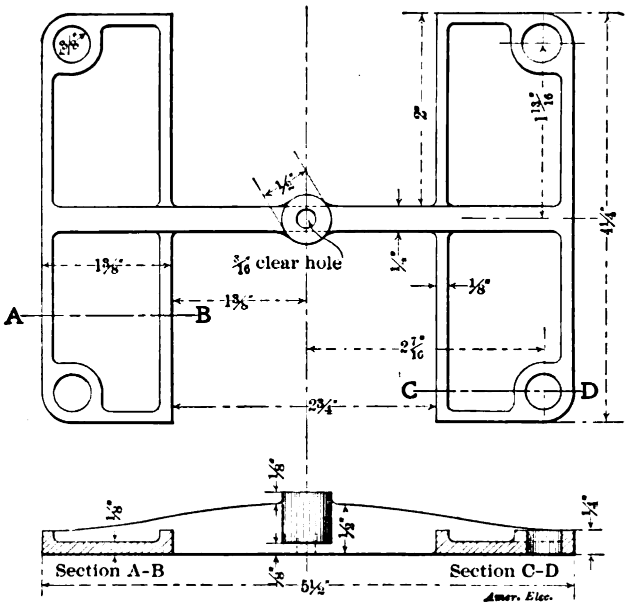


FIG. 7.—CLAMPING PLATE; SINGLE-PHASE TRANSFORMER.

The secondary coil is wound on the bobbin first. It consists of 3 layers of No. 20 double-cotton-covered magnet wire in each bobbin (there are two, one on each leg of the core) with 60 turns in each layer: 180 turns in each coil. After winding this coil, it must be covered with six layers of oiled linen 0.01 inch thick, wrapped in one continuous strip the full width of the bobbin between heads (2 1/2 inches). Then four pieces of hard fibre 1-16 inch thick and of the shape and size shown by Fig. 6 must be glued to the inner face of each head so that when the primary wire is wound on top of the secondary the wires cannot pull down between the head and the edges of the oiled linen.

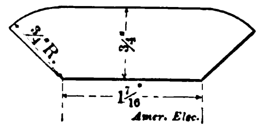


FIG. 6.

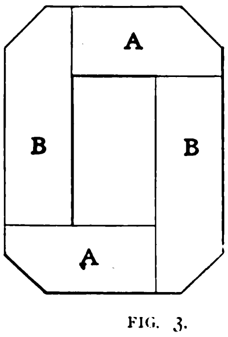


FIG. 3.

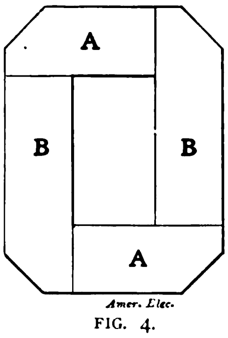


FIG. 4.

The primary winding in each bobbin consists of 8275 turns of No. 36 double-silk-covered wire, the silk covering being 2 mils thick; that is to say, the diameter of the wire measured over the insulation is 4 mils greater than the bare diameter. After winding on the first four layers of the primary, these should be covered with a thickness of the 0.01-in. oiled linen; a layer of this should be put in on top of each four layers of wire through the winding; six strips will therefore be required for this purpose.

The outside of the complete coil should be covered with six layers of oiled linen and a protecting layer or two of heavy duck, the outer layer of this being heavily varnished. The two primary coils are to be connected in series so that if direct current were passed through them they would both magnetize the core in the same direction as to the complete magnetic circuit. The two secondary coils are also connected in series, and in agreement with each other.

After the core-plates are assembled, with the coils in place, of course, they are to be clamped tightly together by means of two brass plates of the shape and dimensions shown by Fig. 7, and five steel rods 3-16 inch in diameter, threaded at both ends; the clamping plates are to be drawn together by means of nuts on the ends of the rods. The plates must be insulated from the core by means of hard fibre facings 1/8

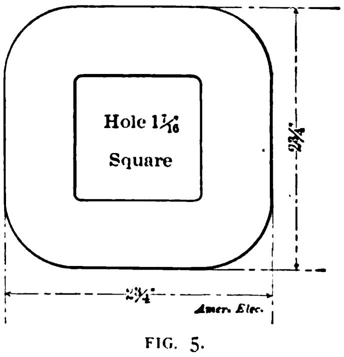


FIG. 5.

inch thick, the full size of the plate outlines. The rods in the four corner holes are insulated from the clamping plates by means of fibre bushings, one of which is shown in Fig. 8; the central bolt need not be insulated.

The two-phase transformer core is made up of sheet steel strips of four sizes; the shapes and dimensions of these are given in Fig. 9. The complete core, without the coils, is shown in Fig. 10; it is built up in somewhat the same manner as the core of the single-phase transformer. The first layer is put down as shown in Fig. 11, the second layer as in Fig. 12, the third layer like the first, and so on. The complete core must be 40 sheets thick.

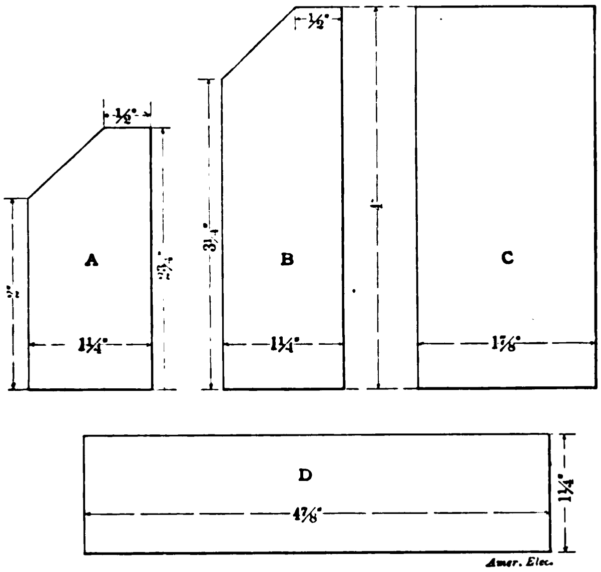


FIG. 9.—CORE STRIPS.

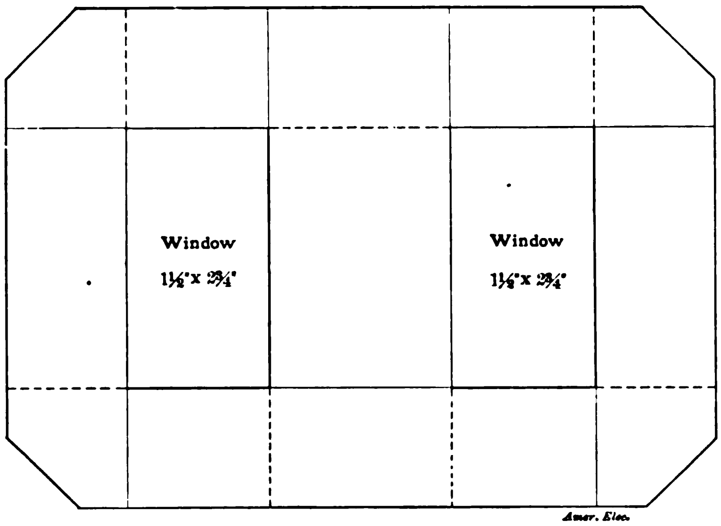


FIG. 10.—TWO-PHASE TRANSFORMER CORE.

This transformer has two distinct sets of coils, one set located on each of the outside legs, *B*, *B*, Figs. 11 and 12. The bobbins are of exactly the same size and construction as those described for the single-phase transformer. The secondary coil on each leg consists of 720 turns of No. 20 double cotton-covered wire, which will make about 12 layers. A tap must be brought out from the middle of each secondary coil; that is to say, after 360 turns have been wound a loop should be carried through a hole in one of the heads of the fibre bobbin and the winding continued without cutting the wire. The object of this middle tap will appear later on. Each secondary coil must be covered with six layers of 0.01-inch oiled linen and four fibre cheek pieces glued to the inner face of each bobbin, as in the case of the single-phase transformer.

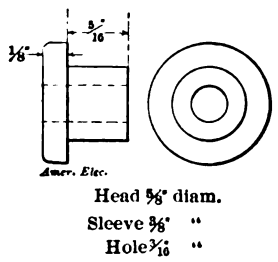


FIG. 8.—TIE-ROD INSULATOR.

Each of the two primary coils consists of 16,550 turns of No. 36 double silk-covered wire. A layer of 0.01-inch oiled linen must be inserted after each third layer of the primary winding, and each complete primary coil protected on the outside by a wrapping of six layers of oiled linen and one or two layers of heavy duck, the outside layer being heavily varnished.

The core strips are compressed by means of two brass clamping plates of the shape and dimensions shown by Fig. 13, and six ¼-inch steel rods with nuts and washers at both ends. The rods must be prevented from metallic contact with the clamping plates by means of insulating sleeves, as in the case of the single-phase transformer; the dimensions of the sleeve are as stated in Fig. 14.

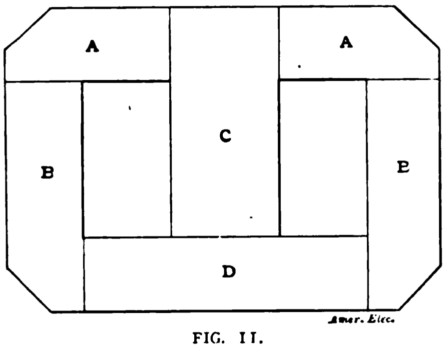


FIG. 11.

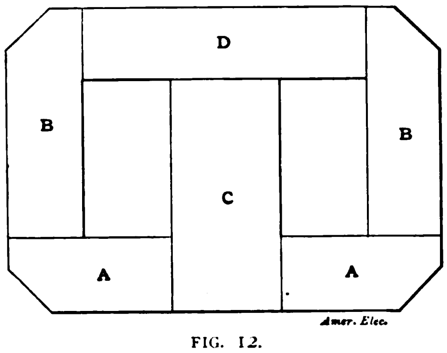


FIG. 12.

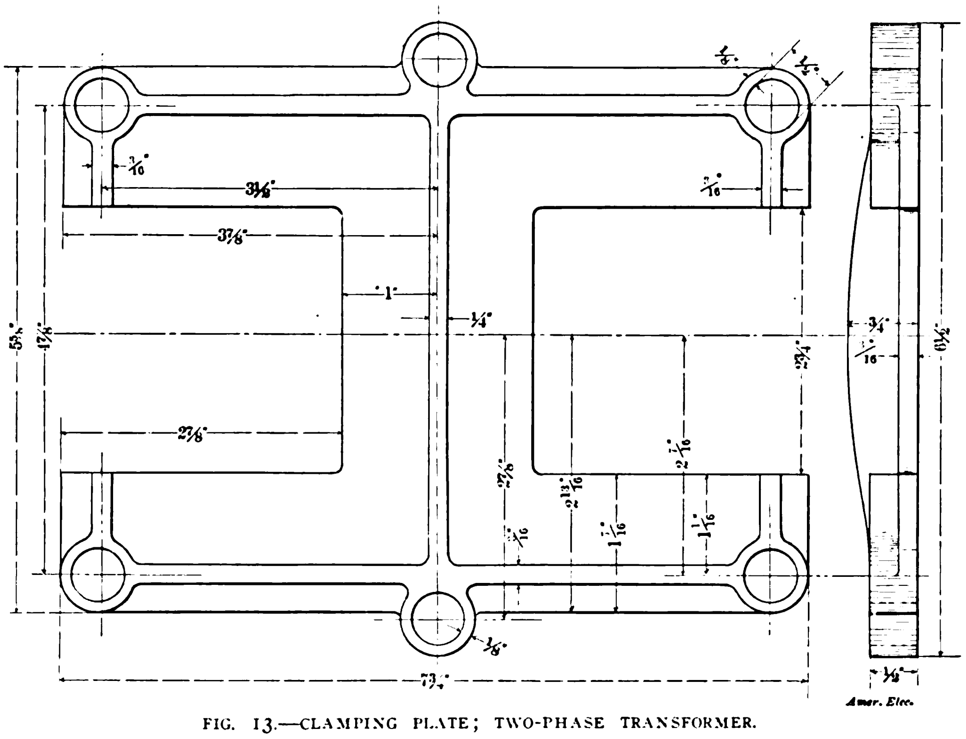


FIG. 13.—CLAMPING PLATE; TWO-PHASE TRANSFORMER.

The connections of the transformers and lamps are shown by Fig. 15. The primary winding of the single-phase transformer must be connected to phase *A* of the bus-bars through a double-pole switch. One terminal of the secondary winding is connected to the neutral point of the lamp circuit which is X-connected, and the other terminal is connected to both of the middle taps of the secondary windings on the two-phase transformer. The free terminals of the two-phase secondaries are connected to the free terminals of the four lamps, as shown in the diagram, and the primary windings of the two-phase transformer are connected through the usual plugs and sockets to the main switch of the incoming generator. If the connections are properly made with respect to the phase relations of the various coils, the lamps will glow in succession as the phases of the incoming generator successively agree with and oppose phase *A* of the system; this will give the effect of a revolving light, the speed of which will be proportional to the difference between the speed of the incoming generator and that of the machines already in circuit, and the direction clockwise. As the incoming generator approaches synchronism, the speed of the "revolving light" will decrease, and when exact synchronism is attained, the top lamp (*a*) of the group will glow steadily and the others will remain dark.

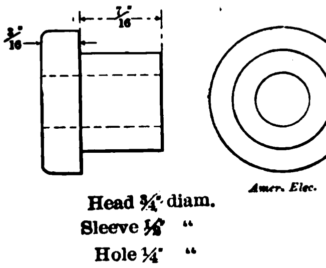


FIG. 14.—TIE-ROD INSULATOR.

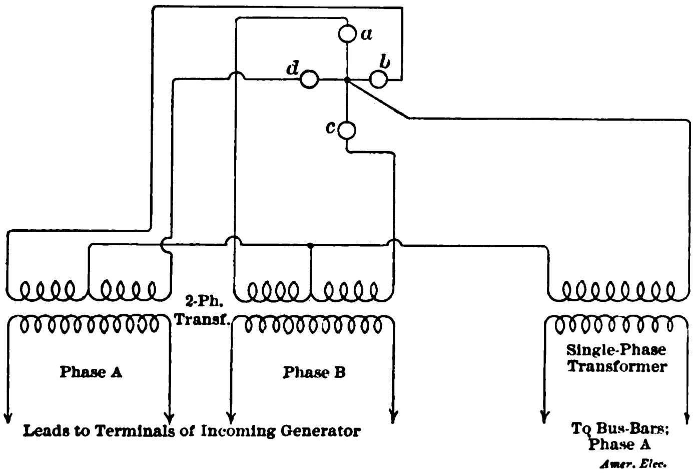


FIG. 15.—DIAGRAM OF CONNECTIONS.

It should be remembered that the steady glowing of either of the other lamps alone indicates identical speeds at the generators, but not coincidence of phases; if the lamp *b* glow steadily, it indicates that the generators are running at the same speed, but that phase *B* of the incoming machine is in step with the phase *A* of the system, and the machine must, of course, not be thrown in.

The lamps should be rated at 100 volts and of low efficiency—say 64 watts consumption. Both of the transformers are designed for a primary e.m.f. of 2300 volts, and the two-phase transformer for 100 volts per complete secondary coil (50 volts between the taps and free terminals); the single-phase secondary should give 50 volts. All of the secondary voltages should be measured, however, and lamps chosen which are of at least twice the voltage of the single-phase secondary, and preferably a volt or two higher.

It is as well to repeat the warning given in the beginning of this article to the effect that the transformer windings must be most carefully handled and insulated in view of the high primary voltage. It is also essential that the rods which draw the clamping plates together be reliably insulated from the plates and from the core; it will be found a good plan to wrap them with a couple of layers of tape after the core is assembled.

◆

Gas for Power—A report from U. S. Consul Mahin, Nottingham, England, says: A large undertaking is now being developed some 30 miles southwest of this city, where material is abundant and industries to consume the gas are numerous. A company, incorporated with a capital of $1,000,000 proposes to supply gas to a territory covering 120 square miles, generated at a central station near the middle of this area and at several other stations to be placed at convenient points. It is stated that the gas will be transmitted long distances through pipe mains laid underground without depositing any tar. The purified gas, after being compressed in horizonatl compressors driven by a steam engine with Corliss gear, enters the trunk mains at about 7 pounds pressure per square inch. At present it is intended to take the gas about 6 miles from the central station, which is capable of producing daily about 40,000,000 cubic feet of gas. The population of the entire territory of 120 square miles, to be eventually supplied with gas, is 640,000. The stack costs from 60 cents to $1.75 per ton, dependent upon distance from a coal pit. The price of the gas to the consumer varies from 2d. to 4d. (4 to 8 cents) per 1000 cubic feet. This is from one-seventh to one-fifteenth the price of other gas in this section. The process altogether is claimed to be by far the cheapest way of making coal gas known at present.

ENGINE ROOM MANAGEMENT.

BY WALTER W. EDWARDS.

Assuming that fires have been lighted under the boilers and that about 20 pounds of steam is showing on the gauges, the engineer in charge of a steam plant should, at this juncture, leave his chief fireman in charge of the fireroom while he turns his undivided attention to the machinery in the engine room. If there has been no steam in the boilers for a few days, the boiler stop valves will be shut, and it is the best practice to open these valves while the steam pressure in the boilers is still low. If the practice is followed of waiting until the full working pressure on the boilers is reached before opening the valves, there is a great deal of unnecessary strain brought on the main steam pipes because of the greater difference in temperature between the pipe and the steam than there would be between the pipe and low pressure steam. The unequal expansion due to this difference in temperature is always excessive, and as the strain of the high pressure is also brought to bear at the same time, there is much more danger of rupture than would be the case if steam had been admitted when the pressure was low.

Of course, when the full pressure already exists on the boilers there is nothing to do but to admit the high pressure steam. In any case, all the drains on the main steam line should be opened first, and then the main stop valve barely eased off its seat so that a little steam will blow through the line and out at the drains. By doing this carefully, the entire pipe can be warmed up to the temperature of the steam without having any pressure on it at all. By following this method only strains due to expansion are set up in the steam pipe, and these are applied so gradually that the danger of a rupture or of causing the joints to leak is reduced to almost nothing. When the line of pipe is thoroughly warmed up, the drains may be closed one at a time and the pressure will gradually rise until equal to the boiler pressure. The main stop valves on the boilers then should be opened wide.

It may seem at first thought that directions for opening or closing a valve would be unnecessary, but an engineer of experience around steam plants knows to his sorrow that such is not the case. A valve, whether it is large or small, should be opened slowly until the desired amount of opening is obtained. If it is to be wide open, the valve stem should be turned until the valve cannot be opened any wider; then it should be turned back about one quarter of a turn and left there. Under no circumstances should it be jammed wide open; if it is, the expansion that takes place when the valve becomes hot often makes it very hard to turn the valve stem back again, and because of this, an oiler or fireman may conclude that the valve is not open at all, and put his pocket monkey wrench on the valve wheel and give it a jerk. The natural result is that the valve stem is twisted more and more each time until some day it breaks. A little thing like a valve stem twisted off does not bother our would-be engineer at all, because he knows that he can still open and close the valve by means of a six-inch Stilson wrench which he immediately proceeds to get. A small Stilson is as easily carried as a small monkey wrench, so he thinks. While on this subject, a word of protest against using a wrench to open and close valves may not be amiss. If the valves of a plant are kept in proper condition, there is no excuse for the practice of carrying a wrench in the hip pocket for use on valve stems or wheels. The only advantage that it offers is that if the hand wheel on the stem should be hot, the danger of burning the hand is obviated, but if a little waste is carried in the pocket even this excuse fails. In a well-regulated plant the monkey wrench is left on the tool bench where it belongs.

The question of whether steam shall be left on the main steam pipe all night or not is one that has provoked much discussion at one time or another. Each way has its advantages and disadvantages so that a decision must be a choice or compromise between them. If steam is left on the pipe, a considerable quantity of steam is condensed during the night, and therefore more heat taken from the boilers. This in itself is of small consequence as the boiler fires are banked at night so that the difference in the amount of coal burned would be very trifling, but unless very efficient means of draining the steam line is provided, the water of condensation stands in the pipe with a full head of steam on it, and this is certain to cause leaks and eventually the blowing out of gaskets between the flanges of pipe joints.

The reason a line of steam piping will leak when filled with water under boiler pressure and will hold tight when subjected to the same pressure without the water, is to be found in the fact that the water will fall in temperature and yet have its pressure maintained by the steam in the boiler. As the water in the pipe cools, the pipe contracts and this opens leaks that do not exist when the pipe is expanded. The contraction of the pipe lengthwise reduces the grip that the flanges have on the gaskets between them, and the pressure forces the water out or ruptures the gaskets between the bolt holes of the flanges. With steam the case is wholly different. The temperture of saturated steam depends on its pressure, and as the temperature falls the pressure also must fall, so that when the steam line has cooled and contracted there is no pressure on it, and consequently it does not leak. If there is efficient means of drainage and the steam line has been given a proper incline so that the water runs to the drains, this objection to leaving steam on the pipe over night no longer holds good.

Another disadvantage of leaving the steam on an engine supply pipe and allowing it to fill with water, as shown in Fig. 1, is the very great danger that exists when the pipe is drained in the morning by means of the small drain under the throttle. The lower part of the pipe is filled with cold water while the upper part is filled with steam having a temperature of 300° or 400°. This means that at the surface of the water in the pipe there is a very great difference in temperature within a length of less than an inch and as the water is drained out, the various parts of the cold pipe pass almost instantly from a moderate temperature to the high temperature of the steam. The effect on the pipe of such treatment can well be compared to the effect that would be produced if a plug of steel having a larger diameter than that of the pipe were forced through the latter. Every time it is done this action is repeated, so that it is little wonder such treatment often results in the rupture of the pipe line and loss of life.

Both of these disadvantages may be overcome by automatically draining the pipe through an efficient steam trap, and with this provision, leaving the steam on the line at all times has the very great advantage that the racking due to warming up is avoided. There is also less labor involved if the steam is left on, as climbing up on the boilers to handle large valves is always a hot, disagreeable duty.

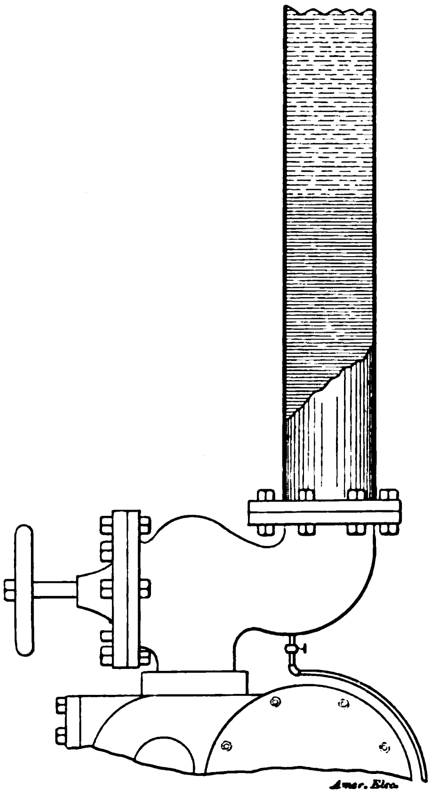


FIG. 1.

When full pressure steam is up to the throttle and the engineer has made sure that all water of condensation has been removed, he should next turn his attention to the engine itself. The cylinder drains should be looked at so as to make sure that they were opened when the engine was stopped. It is always customary to fit a water service to marine engines so that cold water may be circulated around all bearings, which are cored out for this purpose. This practice is being adopted more or less in the larger sizes of stationary engines, and where this is done water should be turned on some time before the engine is started so as to get all the bearings as cool as possible. The oil cups should next be looked after and started to feeding. If there is a condenser attached, all the water valves should be inspected to see that they are open.

If it is possible, the circulating water should be started first and then the air-pump, so as to have a good vacuum before the main engine is started. If a steam jacket is fitted to the low-pressure cylinder, steam should be turned on and the reducing valve set so as to give about 10 pounds pressure on the jacket. The trap on the jacket drain should be inspected so as to be sure that it discharges properly. After all these precautions have been taken, the throttle valve should be opened just enough to allow steam to enter the cylinder, but not enough to cause the engine to turn. Warming up in this way makes it certain that the cylinder will not be cracked by a sudden rush of steam against cold metal. When the engine is thoroughly warmed up, the throttle may be opened wider and the engine allowed to turn slowly. The drains should be kept open throughout the whole process of warming, and should not be closed until the engine is fully up to speed.

After the engine is running, the oil feeds should be cut down so as to give each bearing the amount of oil that experience has shown that it needs. The oiler or the engineer on duty, if there is no oiler, should regularly feel of each bearing or joint where it is possible that heat may be developed by friction. The crank-pins and cross-heads may be felt by the hand with a little practice, as well as bearings that are stationary. The hand or finger should be extended toward the bearing very slowly until the moving part just touches the fingers as it passes. In doing this, care should be taken and such a part of the revolution chosen so that the moving parts will be moving away from the fingers an instant after contact or an accident may result. This knack of "feeling" an engine is easily acquired, and is not nearly so dangerous as it may seem.

During the running of the engine there are two evils against which the engineer must always be on guard. One is priming in the boilers, and the other is hot bearings on the engine. Neither of these troubles gives much warning of its approach, and it is consequently imperative that the engineer shall at all times be alert and watchful. Priming usually makes its presence known by a slapping sound in the cylinder, which is produced by the piston striking the water and throwing it against the cylinder heads. As soon as this sound is heard, the cylinder drains should be opened and a hurried inspection made of the separator to see if it is working all right. If there is considerable water in the glass on the separator, the by-pass on the trap through which it drains should be opened wide.

The speed of the engine should not be reduced except as a last resort, as this means the advertising of the difficulty to the entire establishment, or in the case of an electric light central station, to the entire city. When these precautions have been taken in the engine room, the engineer should visit the boilers and order the firemen to cover the fires of the priming boiler with fresh fuel. Meanwhile, the water level in the gauge glasses should be noted, and if any of them show high water, the bottom blow should be opened and the water brought down to its proper level. These precautions will, in almost every case, stop the priming, but if they do not, the stop valve on the offending boiler should be partially closed so as to wire draw the steam from that boiler and thus dry it. Dirty water may cause priming, and if this cause is suspected, the bottom blow should be freely used. When the priming has been stopped by some or all of these remedies, the bypass on the separator trap may be closed, and also the cylinder drains.

Hot bearings may result from a number of causes, such as lack of oil, grit or dirt of some sort, badly fitted brasses, poor adjustment of brasses or a bearing too small for its work. A hot bearing caused by a lack of oil is in every case the direct result of carelessness on the part of the attendant. It is no excuse to say that the oil pipes from the cups became clogged with dirt; that is what the attendant is paid to prevent, and if he does not, he is not doing his duty. When the heating is caused by grit in the oil there is more excuse for a hot bearing, but careful watching will usually enable the engineer to catch it in time, and by a liberal supply of clean oil the dirt can usually be washed away. Badly fitted brasses can cause heating by concentrating the pressure of the journal on an insufficient bearing surface, thus causing excessive friction at one point. As the area of the bearing surface may be reduced by poor workmanship in fitting, by the brasses being out of line, or by the bearing having been originally of too small a size, it follows that any of these may cause hot bearings. The remedy is to fit the brass properly, line up the engine, or have larger brasses made, as the case may be.

When brasses are keyed up too tightly after making repairs, the friction is, of course, excessive and the bearing is very quickly heated. Besides heating quickly from this cause, the time at which it occurs is just after the engine is started, and hence the engineer and oiler are very apt to have their attention called elsewhere, and therefore cannot concentrate it on the engine. If a liberal supply of oil will not stop the heating, recourse must be had to other means. Flowers of sulphur, or graphite may be mixed with the oil and fed to the bearing, or a little soft soap or soapy water will reduce the heat; if these fail, the engine must be stopped and the brasses loosened. When using soapy water it is well to have the water heated some because cold water may crack the brasses if they are very hot. Cold water will cause the outside of the brass to contract and compress the inner parts, so that when the inner parts are also cooled, the brass grips the journal and will always cause heating until it is refitted. When a bearing is cooled by the use of water, it should be immediately flooded with oil as soon as the water is shut off, as the water will undoubtedly wash all the oil out of the bearing.

Incessant vigilance is essential to successful engine management; a careful attention to duty when on watch, a thorough knowledge of the business and a neat, well-kept engine room are characteristics that every engineer should strive to acquire to the highest degree.

TESTING RECORDING WATTMETERS.

BY GEO. T. HANCHETT.

The recording wattmeter is hardly an instrument of precision; it is considered commercially accurate when reading within 2 per cent. Its error varies with its load, the general tendency being to run slow on light loads and slow on heavy loads. This is due to the peculiar way in which the friction of the instrument affects its accuracy. For instance, if the frictional load of the instrument demands a torque equivalent to a certain number of watts, say 30, and the instrument be set to be correct on only one load, on low loads the frictional error, which is fairly constant, will be a larger percentage of the torque of the instrument, and above this point the relation will be reversed. Such instruments are generally equipped with a starting coil, which is intended to just compensate for the frictional load. This starting coil is of fine wire connected in series with the armature, and its field influences the latter. With the coil connected as stated, the torque of the armature, due to the starting coil, becomes proportional to the square of the applied voltage. Therefore, it is evident that if there is any departure from the voltage at which the instrument is intended to run, the torque due to the starting coil will become greater or less than the friction torque which it is intended to balance.

As it is impossible to have constant voltage, and also impossible to set the starting coil for absolutely correct compensation, the ordinary method of testing a wattmeter on a constant load and checking it with a voltmeter and ammeter is not satisfactory. From the consumer's point of view the only really satisfactory test is one made over a complete cycle of 24 hours, covering all the varying loads which are employed in practice on that particular instrument. To do this with a voltmeter and ammeter, taking periodic readings, is tedious and expensive work, and a better method is to use a second recording wattmeter, which is known to be correct, and install it in series with the first one. If this meter is calibrated in the laboratory, both before and after the test and while recording a number of different loads, its readings can be relied upon when proper corrections are applied. The actual work of testing a consumer's wattmeter is therefore largely eliminated, for the only thing necessary to do on the ground is to cut the standard meter in circuit, read both meters, and 24 hours later read and remove the standard instrument. It is not even necessary to know the elapsed time precisely.

The potential coil of the standard instrument should, of course, be connected back of the instrument to be tested, in order to prevent any flow of current in the standard instrument from being registered on the meter to be tested and thereby causing the reading to be in error. In doing this there is, of course, a slight error due to the fact that the potential coils of the standard instrument are not connected to the same terminal of the instrument to be tested. For closer accuracy, therefore, it is better to connect the potential winding of the standard meter to the same point as the potential winding of the meter to be tested, and knowing the resistance of the former winding and (in this case) the elapsed time, a proper correction can be applied.

The recording wattmeter as usually built is not a very desirable or convenient instrument for connecting in a service circuit. For testing apparatus, the writer has found it convenient to adapt standard meters to the purpose, and two forms which have been found useful are shown in the accompanying illustration. The meters themselves are ordinary instruments bought on the market; but their cases are removed, and the mechanisms are installed in wooden cases equipped with three adjustable legs by means of which the instruments may be leveled.

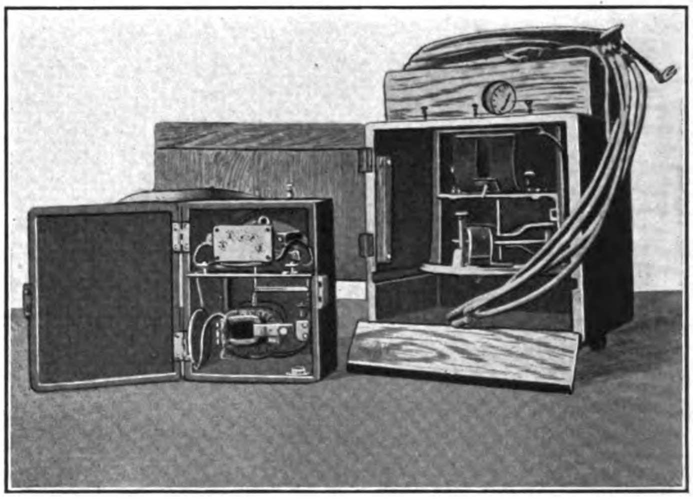


FIG. 1.—PORTABLE WATTMETERS FOR TESTING PURPOSES.

The larger instrument is equipped with four leads and terminals, one lead going to each series coil terminal. This enables one to connect the series coils in series or in multiple with each other, or on the three-wire plan. By building the boxes a little larger there is room for these leads underneath the instrument itself. The revolving disc of the instrument is raised or lowered by means of a spring and a screw which shows in the foreground; upon slacking off this screw the spring lifts the disc and the spindle of the instrument is thereby raised from its jewel, thereby enabling the instrument to stand transportation.

The first dial is equipped with a long delicate pointer, and a large dial divided into 100 parts in order that it may be read more closely is substituted for the regular dial. A small bullseye in the top of the box makes it convenient to read this dial and the one next to it. The instrument is equipped with two potential coils, for 240 and 120 volts respectively. Three binding posts on the top of the case make it easy for either the one or the other to be connected in circuit. It will be noted that the case has two doors; the upper door can be locked, thereby shielding the instrument from interference, when the lower door is opened to permit the leads to be led off to any convenient point. Each of the series coils of this instrument has a capacity of 50 amperes, so that when they are connected in multiple the meter will measure a load taking 100 amperes. This with the combination of the shunt coils gives the instrument a wide range of possibilities.

The smaller instrument shown in the engraving is connected on the same plan and installed in an ordinary portable instrument box. This instrument is not equipped with leads, however; the terminals of the two series coils are carried to four binding posts on the back of the case and the potential coil terminals are brought out on the top. A small level is screwed to the floor of the box, thereby enabling the user to properly adjust the meter with reference to the vertical before a test is made. Both of these outfits are "home-made" as far as the installation of the meters in their boxes is concerned, and the addition of leads, screws and potential coils. They have proven very serviceable for the work for which they were intended, and have saved a great deal of valuable time; it is because of their advantages in these respects that the writer recommends the arrangement for general work.

A wattmeter test of the kind mentioned herein has a value which the ordinary voltmeter and ammeter test has not. In the first place, it tests the entire instrument and will detect the possibility of a wrong recording mechanism being installed in the instrument to be tested, or the use of a wrong constant, which the rotation does not do. It will also detect any tendency of the instrument to stick. It often happens that a correctly indicating recording wattmeter will stick, due to some very slight obstruction, and will start up again after a jar has removed the obstruction.

An instrument can be modified into the form described at an expense not exceeding $10 in addition to the cost of the instrument itself, and it is useful not only for testing other meters, but for any work where watt-hour consumption is involved, such as life tests on lamps and the like.

In testing meters which measure the input of elevator motors or other machinery where the power fluctuates rapidly, an instrument of this kind is the only satisfactory apparatus which will integrate the fluctuations and give a correct check upon the meter which is used for commercially measuring the load.

In three-wire testing the use of such an instrument obviates the necessity for two ammeters, or at least two shunts and periodic connection. For all of these reasons the instrument has appeared to the writer to be worth while in many cases, and he has ventured to illustrate and describe it in the hope that others may find it so.

PLUG AND SOCKET CONNECTORS FOR ELECTRICAL TESTING ROOMS.

BY T. C. EMERSON.

Ordinary screw binding posts and common insulated wire are not at all satisfactory for making test connections. Wires after being tightened under screw binding posts a few times become compressed, bent out of shape and nicked and are apt to break off. The break may occur in some circuit, such as the field connections of a shunt-wound motor, where results could be very serious. There is also a tendency on the part of test men to set up the binding screws too tight, using plyers as a lever and frequently twisting the screws off. Moreover, ordinary binding posts when subjected to the vibrations of a running machine will usually work loose.

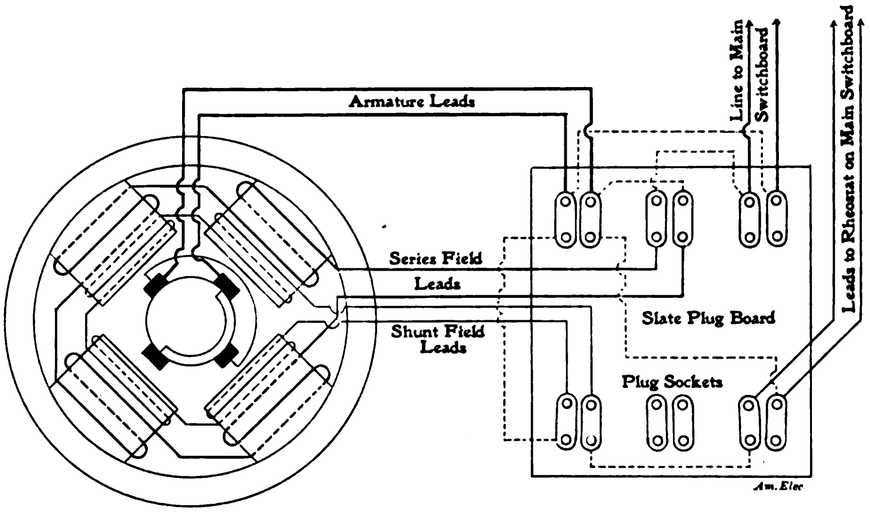


FIG. 2.—DIAGRAM OF CONNECTIONS.

The method adopted for connecting up apparatus in the electrical laboratory at Pratt Institute, Brooklyn, N. Y., has been found a very satisfactory one. Here the terminals from the different parts of the apparatus, switchboard instruments or rheostats are brought to brass sockets mounted on slate slabs. Brass split plugs, which make reliable contact in the sockets and fit firmly enough not to be easily displaced attached to flexible cables, are provided for connecting the sockets. The cables are of various lengths. Some have plugs on both ends and some have a plug on one end only and a short piece of about No. 6 copper wire soldered to the other end; this wire terminal will enter readily into the binding posts of measuring instruments and rheostats.

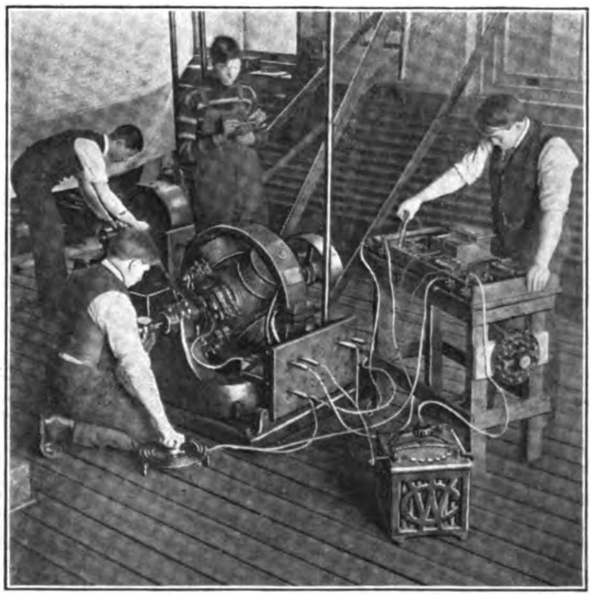


FIG. 1.—TESTING MULTIPOLAR MOTOR.

Fig. 1 shows students making a test of a multipolar machine running as a motor, and illustrates the application of the method under discussion. As a load the motor drives the dynamo in the background, which furnishes current to a lamp bank or water rheostats. A diagram of connections of the machine and the plugs and socket switchboard attached to it is shown in Fig. 2. In this diagram it will be noted that the leads of the series field winding terminate at a pair of sockets, as do the leads from the shunt field winding and the leads from the armature. Near the upper right-hand corner of the plug and socket switchboard are two sockets which connect to leads running to the main switchboard. These may be used to take current from or supply current to other apparatus. Near the lower right-hand corner of the slab are two sockets which are connected with a rheostat on the main switchboard (not shown). Obviously, it is possible by using the proper sockets and cables, with their connecting plugs, to connect the machine for shunt, compound, series or separate excitation, and instruments, resistance or rheostats may be connected in any desired circuit. The dotted lines indicate the plug and cable connections when the machine is to be tested as a compound-wound dynamo delivering current to the leads which extend to the main switchboard. The measuring instruments that would have to be included in some of the circuits, if the machine were actually under test, are not shown. A rheostat mounted permanently on a distant switchboard is connected to the lower right-hand pair of sockets for controlling the field current.

Fig. 3 is a view of another portion of the same laboratory. Not all of the machines shown are equipped according to the method described, but it is probable that in time all apparatus will be uniformly arranged in this respect. In the upper part of this engraving, on the gallery, is shown a plug and socket switchboard to which leads extend from the lamp bank shown behind it and from other parts of the laboratory. The wiring is so arranged that current generated in another part of the laboratory can, by the insertion of a few plugs, be brought to this switchboard. At this point it is available for use on the testing floor. Below the transformers, which are installed without cases, is shown another plug and socket switchboard. The different coils in the transformers are all connected by leads to sockets in the board beneath them, and any desired connections can be arranged by properly inserting the plugs of the connecting cables which have regular socket plugs on both ends. The transformer coils may be connected in series or in multiple, and by means of the same boards the transformers themselves may be connected in either series or multiple.

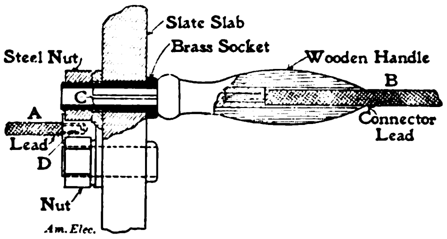


FIG. 4.—SECTIONAL VIEW OF PLUG.

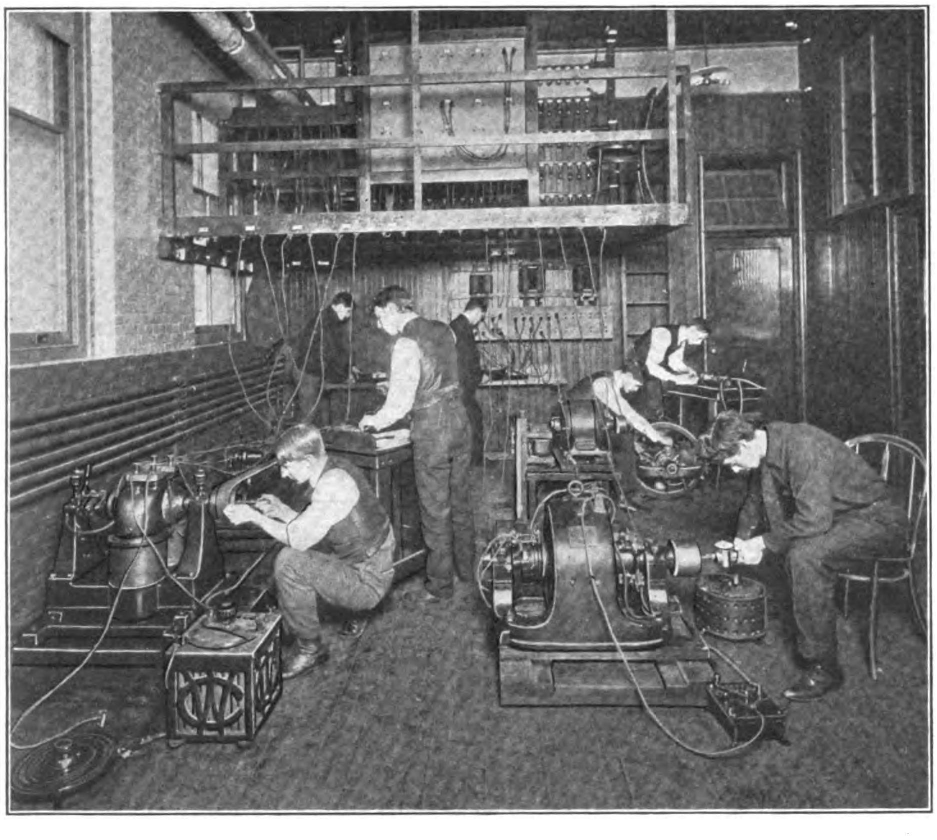
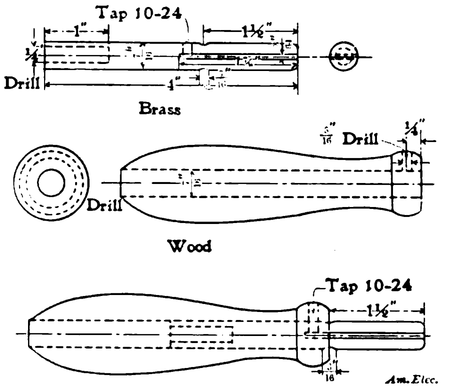


FIG. 3.—ELECTRICAL TESTING LABORATORY AT PRATT INSTITUTE.

Fig. 4 shows a partial section of a standard plug inserted in a socket which is mounted in a slate slab, with the wire leading to the socket and the flexible cable leading from the plug. The wire marked *A* is soldered into the hole in the socket. To do this, the wire is first scraped and tinned, of course, and the socket casting is taken from the slate board and held in such a position that the hole *D*, prepared to receive the wire, is vertical. The casting is heated with a blow torch and the hole filled with solder. The wire is thrust in and the whole quickly cooled with a piece of soaking wet waste. The cable *B* is connected in the same manner to the plug rod. Dimensioned detail drawings of all the parts are shown in Figs. 5 and 6.



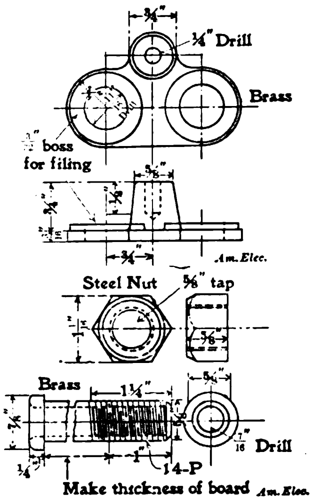


FIG. 5.—DETAILS OF PLUG AND SOCKET.—FIG. 6.

When it is desired to connect a voltmeter across two plugs, No. 18 flexible cord, having heavy insulation, may be used for voltmeter leads. The ends can be placed in the socket and the plug thrust in. There is enough elasticity in the plugs, because of the slot shown at *c* in Fig. 4, to allow this. The wires will be held firmly and will serve to hold the plugs in the sockets even more firmly.

At Pratt Institute the construction of the plugs and sockets and the smaller of the slate boards is made a part of the regular course of the electrical student; the machine work on the brass parts is done by students in the machine shop. The wooden handles are purchased, with brass ferules on them, as they can be obtained more economically in that way than by making them in the Institute wood shop. They are ordinary file handles and the 7/16-in. hole is bored through them in the shop. It will be noted that the plug proper is simply a piece of 7/16-in. brass rod slotted in one end, with a hole drilled in the other end and two small screw holes drilled in the slotted end. Flexible conductors, composed of many strands of fine wire, well insulated and braid covered, suitable for connecting the pairs of plugs, can be purchased from any of the electrical supply houses.

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SOME EFFICIENT METHODS OF MANAGING TELEPHONE INSPECTION DEPARTMENTS.

BY CHAS. H. COAR.

The expeditious correction of faulty line or instrument operations in a telephone exchange should be considered just as important as the acquisition of subscribers, and in consequence the inspection department should be regarded as a vital part of the exchange. However, in many exchanges equipped with up-to-date facilities one may find methods being practiced in the inspection department which are not at all in keeping with the remainder of the exchange.

Upon investigation not a great many exchanges will be found in which records of the individual lines are kept, from which it is possible to learn whether a line is absorbing or paying capital. Inefficient management of the inspection department is certain to cause a needless expenditure of funds sooner or later, to say nothing of the results that poor service effect in a community. But it is not the intention of the writer to discuss this effect or the apparatus directly involved in the testing; it is more to the point just now to sum up some of the qualifications necessary for a wire chief or chief inspector and also the inspectors or repairmen.

The chief inspector should be thoroughly acquainted with testing instruments and methods. He should understand telephone construction in all its branches. He should be well enough acquainted with details of construction, testing and repairing to enable him to judge a day's work. He should be able to explain the causes, reasons and remedies for faulty operations. He should be able to examine all applicants for positions under his jurisdiction in such a manner that only competent persons will be employed. He should be willing to inform his employes to the best of his ability on all matters which would tend to make their work easier or more intelligible to them.

Inspectors or repairmen may be divided into two classes. In the first class there would be such men as are capable of locating and repairing trouble whether it be in the outside construction, the inside construction or the instrument itself. In the second class there would be such persons as are capable of locating and repairing trouble occurring in the interior work or instrument. To be a competent workman in the first class, one should have had experience in construction work and the installation of instruments, while one experienced only in the installation of instruments should be eligible for the second class.

Many inspectors have a haphazard manner of doing their work; a great many of them cannot diagram or explain the circuits of a bell they have repaired for years; they do not realize the paramount importance of a so-called insignificant fuse, and they consequently dispense with fuses many times when it is easier to insert a piece of wire. It is frequently the case that wires are displaced from proper positions and left so by their unintelligent search for trouble or eagerness to finish a case. They hardly deem it necessary to solder a joint. These and other items of neglect cause in time a needless expenditure of capital. In many instances such conditions are due to the chief inspector, who has information given him with the intention that it be posted or otherwise given to the employes under his supervision in order that they may become more proficient. This is very noticeable when blueprints are made for the inspection department, which should be hung on the walls or placed where they would be easily accessible to the employes, but which on the contrary are often placed under lock and key for the benefit of a favored few.

Every company having an inspection department will find it very much to its interest to adopt the issuance of bulletins, or other methods, by which concise information can from time to time be furnished to the employes concerning the apparatus, circuits, etc., they have to deal with. Text books, of course, cover general rules and principles very well, but they do not contain much detailed information regarding the apparatus involved in any particular system, therefore the provision of such information would be very beneficial; it not only enables the men to do better work but it also creates a feeling of satisfaction and interest in their work. If information of this description is furnished to the employes it should become part of their duty to acquaint themselves with it.

A very successful method of obtaining good results from inspectors consists of establishing districts in the exchange territory and assigning a district to each man; in this manner an employe can be held more strictly accountable for the work he is doing, and furthermore, the inspector is able to accomplish more in the same time from the fact that he will become familiar with the conditions, locations and needs of the lines in his territory more than he would if he had no special district but was assigned a case here or there as the trouble required.

By arranging the exchange territory in this manner, men having the ability to repair and maintain the lines in districts containing trees, etc., can be assigned to districts where such conditions exist, and men having ability to repair and maintain building wires in business districts can be assigned to such districts. Results are obtained in this manner which are otherwise impossible. For example, if an inspector whose time has been devoted mostly to residence districts be sent to repair a line in a business district, after getting his line location he is usually lost, as he needs a step-ladder, he requires the services of the janitor, or he wishes to get on the roof, and numerous other things all of which take extra time for one not acquainted; the same sort of condition exists in case an inspector from the business district is sent to a residence district where he has trees, etc., to contend with.

In order to facilitate the repairing of telephone lines, complete position records should be maintained of each individual line, so that any line information, such as its pole position, cable conductor, class of service, and address or addresses of the subscribers, can be readily obtained.

A cable record should have space allotted for the following items:

1. Cable number or letter.
2. Route of cable (underground or aerial).
3. Numbers of the terminal poles or boxes the cable feeds.
4. Designation of such poles or boxes as are in multiple with each other.
5. Drop number of line; what class of service the line is, and the number of the cable conductors, preferably arranged opposite each other.

A card record of this description may be made to provide space for one, two or four hundred conductors, and it should be constructed of such material as will allow a considerable number of erasures without becoming unfit; records of this description are usually made in lead pencil on account of the many necessary changes occurring in them, but this is a poor policy.

Pole diagrams or records should conform with the kind of pole they represent, either a distributing pole having circular frames from which the different lines radiate, or the usual lead pole, and space should be allotted for the following items:

1. Number or letter of pole.
2. Location of pole.
3. Number of cable feeding pole.
4. Number of cable conductors.
5. Pin locations; drop number on these locations and class of service of these drops or lines.

It is customary to diagram lead poles facing the direction the lead runs by starting with the left end pin on the top arm and counting to the right on each arm. Whatever method is used, the inspectors should be thoroughly acquainted with it.

The lines records used in the inspection department are preferably in the form of index cards arranged in numerical sequence, with space provided on each card for the following items:

1. Drop number.
2. Pole number.
3. Arm......... Pin.........
4. Number of cable.
5. Number of the cable conductors.
6. Class of service.
7. Address and calls of subscriber.

A card 3½ ins. x 5 ins. will contain all these items and still have available space for five subscribers' names and addresses.

Having described a card system for keeping records of the lines, it will possibly be in order to outline a method of keeping record of the trouble occurring on these lines, and as it is customary in the larger exchanges for a clerk to receive the trouble complaints, after which they are tested and assigned to the inspectors if necessary, a check or slip upon which the clerk may record a report as he receives it will be useful. A report check having space provided for the following items is convenient:

1. Drop number.
2. Date.
3. Pole, arm and pin.
4. Class of service.
5. Time reported.
6. Reported by.
7. Tested.
8. Addresses.
9. Time assigned.
10. Time O.K.
11. Trouble found.
12. Inspector's name.

By ruling a blank sheet of paper in divisions in such a way that a division is provided for each 100 lines in the exchanges, one can tell at a glance if any line is reported out of order. For instance, if subscriber's line No. 1214 was out of order, 14 would be put in the 1200 division on the check sheet. This is a very convenient way of knowing if a line is reported or not, and as such information is often requested by a subscriber or a company official this sheet should not be neglected.

There remains one more check form, namely, the slip which is given the inspector, and in connection with this check it might be well to mention that the slips should be made of good paper, as they are handled or carried about considerably.

The inspector's slip should have space provided on its face for the following data:

1. Drop number.
2. Date.
3. Pole, arm and pin.
4. Class of service.
5. Tested.
6. Addresses.
7. Time reported.
8. Time started.
9. Time O. K.
10. Signature.

On the back the following items should be noted:

1. Trouble found.
2. Remarks.

Assuming that the exchange territory is divided into districts and that each district inspector has a pigeon-hole at the clerk's desk in which the clerk places the line check reports, it will be advantageous to follow a report throughout its customary course.

(*a*) Trouble is received by the clerk, who records it on a report check, noting the time and by whom it was reported.

(*b*) The person doing the testing takes the report check and tests the line, recording the results on the check.

(*c*) If the line is in trouble, a clerk records the line positions, addresses, etc., in the spaces provided and assigns the check to the pigeon-hole representing the district the line is in.

(*d*) The line is given an inspector who fills out the inspection slip with the necessary data.

(*e*) The inspector clears and reports the line O.K. to the trouble clerk, stating what the trouble was.

(*f*) The clerk places the finished report in a pigeon-hole provided for it.

When the inspectors return to the office, the inspector's slips may be compared with the report checks if it be deemed necessary, after which the slips may be placed in bundles suitably marked for reference.

The information contained on the finished report checks can then be placed in a suitable record book, or the report checks can be assigned to pigeon-holes which are intended to hold the finished reports of a designated number of lines. At the end of each month the individual cases of any line may be bound together and stored away for reference. By arranging the check sheets in daily rotation and filing them, one can readily ascertain by referring to them at what date any particular line was out of order, after which any other desired information may be obtained from the record book or report checks.

As the maintenance of toll lines and stations is usually conducted from the inspector's office, it might be well to outline a trouble slip which will be useful in recording the necessary data regarding toll line trouble. A report slip having a similar form to the one outlined herein will have space provided for the principal items mentioned in toll line repairs as follows:

The inspectors should be instructed to note under "Remarks" on the trouble slips all faulty conditions of the lines in their respective districts that they are unable to repair alone, in order that such repairs as require a crew may be made without delay. During stormy weather lines having defective insulation may be traced and the defective spots located, after which they should be repaired at the first opportunity.

Slack wire, loose pins and brackets, twisted arms, insulators off, wires not tied, joints not soldered and all other such conditions which not only present an unsightly apparance but make trouble should be promptly repaired. The inspector's grip should contain with the other accessories some polish and a rag for cleaning dirty instruments, as there is nothing more discouraging to a prospective subscriber than a dirty or grimy instrument. Inspectors should also have impressed upon their minds the necessity of looking for loose contacts, wiping the rust collection off the receiver magnets and diaphragms, displacing bent diaphragms, trying the transmitter and receiver cords for cut outs, retacking loose wire, and such other things as seem to need attention whenever one is sent to repair a telephone; such work may prevent a faulty operation at some future time and consequently a subscriber's complaint. During the time the inspectors have no reported trouble to repair they can inspect the wires and telephones in their districts, but while thus employed they should keep in touch with the office in order to receive any trouble orders.

(Face)

Date ....
Line out of order ....
Is line serviceable ....
Nature and test location of trouble ....
Reported.............M. By ....
Left .... Time ....
By (train or livery) ....
Arrived at trouble ....
Location and trouble found ....
Time O. K. ....M.
Remarks ....
....
Repairman..................

(Back)

Expenses.

R. R. ....
Livery ....
Hotel ....
Labor ....
Incidentals ....
Total ....

Material used.

....
....
....
Repairman ....

Trouble occurring in the cables or cable terminals can best be remedied by men employed in the cable department, and for this reason the inspectors should not go further than the line pin or cable terminal if the trouble is towards the office. After such trouble has been corrected by the cable department, the usual course can be followed. When an inspector has a line assigned to him on which there is trouble, his report should state explicitly whether he cleared the trouble or whether it disappeared of its own accord, in order that the proper precautions may be taken for its location. The writer once employed an inspector to whom he assigned a case of trouble which had bothered the subscriber off and on with a scraping noise during conversation. As it seemed impossible to apply a test to this line when the trouble was occurring, the inspector had orders to inspect the line and instrument thoroughly, and after spending nearly half a day he reported back that he had found a piece of hay baling wire swinging in contact with one side of the line and a guy wire. Believing that this trouble had been cleared, it was recorded, but the next day it was faulty again. Another inspector was assigned to the case and he found and cleared the trouble, which was in the lightning arrester. Learning this, a clear line was assigned the first inspector, who was told that the line had a similar case of trouble. After another half day spent in rest or otherwise, the bale-wire story came in again. But it was his last report with that company, and the general effect this occurrence produced among the men was good.

In conclusion, the writer wishes to impress upon the reader's mind the practicability of systematizing the work of the inspection department, and also state that the adoption of some system similar to the one outlined herein will produce good results, as has been demonstrated in exchanges where no particular pains had been taken in the management of this important department.

PELTON WATER-WHEEL COMPANY'S TESTING ROOM.

BY GEO. J. HENRY, JR.

In designing buckets for tangential water-wheels, there are so many elements to be taken into consideration none of which can be predetermined with any degree of accuracy by any ordinary mathematical process, and all of which are so entirely interdependent that a wrong assumption in regard to any of them produces the most erratic results. Investigators applying the rule of common sense only to bucket shapes have usually ignored some of the most important considerations, and as an operating water-wheel from which any measurements are taken is made up of a number of different parts and any measurements that may be taken from it involve a number of other losses than those of the buckets only, some more reliable method of design has become necessary.

It has been the policy of the Pelton Water-Wheel Company, of San Francisco, always to design a water-wheel for the particular conditions under which it is to operate, invariably making such changes in the buckets as well as all of the other parts of the wheel it builds as will bring about a maximum efficiency. The losses going to make up the total loss in any given water-wheel installation are many in number, and the elimination or reduction of any part results in some improvement. The necessity for the accurate determination of bucket losses as separated from those of windage, journal friction, nozzle and stream losses, made it necessary to devise apparatus of an entirely different nature from anything heretofore used for this purpose.

The use of the prony brake on small model wheels included losses of the windage and journal friction and of the nozzle and stream, all of which were so large compared to the bucket losses in a well-designed wheel that very little reliability could be placed upon it. The following method was therefore devised by the writer for eliminating these losses. The apparatus, which is illustrated in Fig. 1, is installed in a room especially fitted up for the purpose in the Pelton Water-wheel Company's factory at San Francisco.

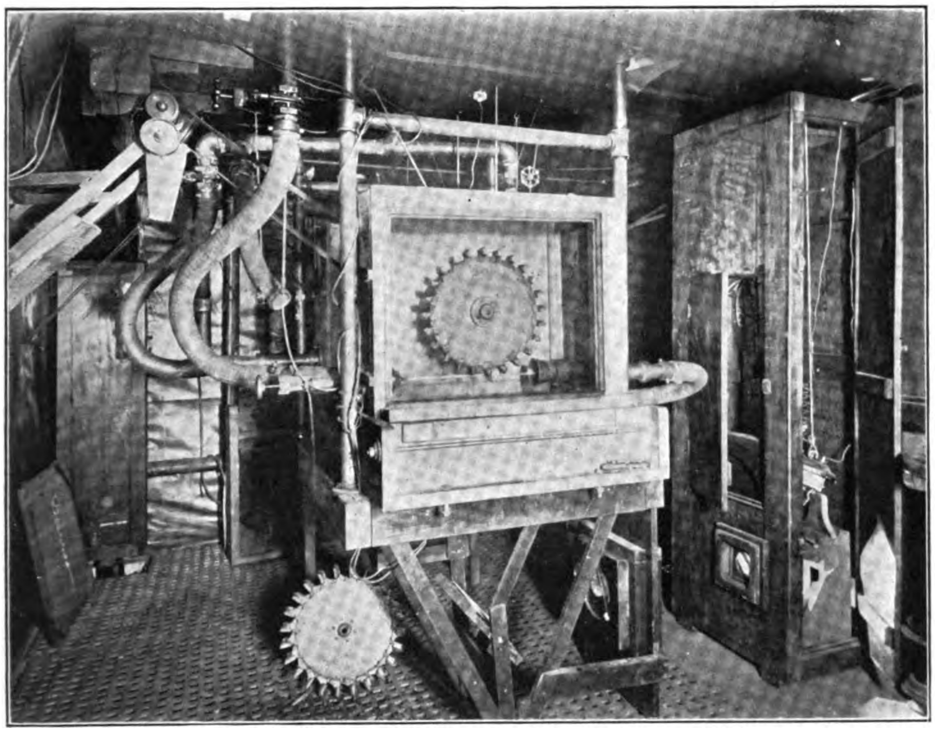

FIG. 1.—PELTON WATER-WHEEL COMPANY'S TESTING ROOM.

A constant head of water of about 50 feet is obtained by a pump delivering an excessive amount of water to a tank on the roof. This tank is provided with a separate overflow pipe, and some water is constantly overflowing. Two separate pipe lines are taken from this tank to the wheels to be tested, one pipe being used to supply each wheel. The general arrangement is shown in Fig. 2. It is obvious that by using a throttling device in the pipe, the head or water pressure at the nozzle outlet may be varied from zero up to the maximum obtainable from the tank, less the friction losses, and maintained absolutely constant. A suitable shaft carried in ball bearings and fitted on one end with a driving wheel is arranged to be rotated by a stream of water from one of the pipes; mounted on the opposite end of the same shaft, in its casing and exactly in position to receive the water properly, is a second wheel fitted with the buckets to be tested. This second wheel and casing are shown in the foreground of Fig. 1. The model wheels are made in any size up to 18 inches in diameter.

Now, by driving the first wheel at any speed at which a measurement is to be taken, and adjusting the water from the first nozzle so as to just carry the wheel at this speed, the power to overcome all of the windage and journal friction of the second wheel is supplied by the first wheel. A prony brake nicely balanced on knife edges is mounted in position on the shaft between the two wheels, a jet of water from the second pipe line is turned on the second wheel, and the prony brake is adjusted until the shaft is running at the same speed as before; the brake is then absorbing the exact amount of power developed by the buckets, independent of the journal friction and windage. It is obvious that measurements may thus be taken at any speed desired and a series of measurements made that will give the efficiency curve for any shape of bucket desired, including nozzle losses.

To separate the nozzle losses, it is necessary to obtain the coefficient of discharge from the nozzle. In the particular apparatus built by the writer and illustrated herewith, each of the nozzles is provided with a mercury column pressure gauge on which readings may be obtained with great accuracy. The pressure is taken from a series of holes 1-16 inch in diameter, drilled completely around the nozzle body at a point just before the contraction of the stream begins, the axes of these holes being normal to the stream axis. These holes open into an annular chamber formed about the outside of the nozzle and connected to the above mentioned mercury pressure gauge. A pendulum, beating seconds accurately and provided with the necessary electrical contacts, is arranged in connection with a suitable timing apparatus to admit the stream issuing from any nozzle tip for an exact number of seconds (independent of the personal error), this stream being caught in a suitable receptacle and weighed. The diameter of the nozzle having previously been calipered exactly, one can readily determine the coefficient of discharge for the nozzle and make the necessary correction in the wheel efficiency curve above mentioned. As a check on the coefficient of discharge, a calibrated sump tank is used in which the discharge from any given nozzle may be caught for a long period of time.

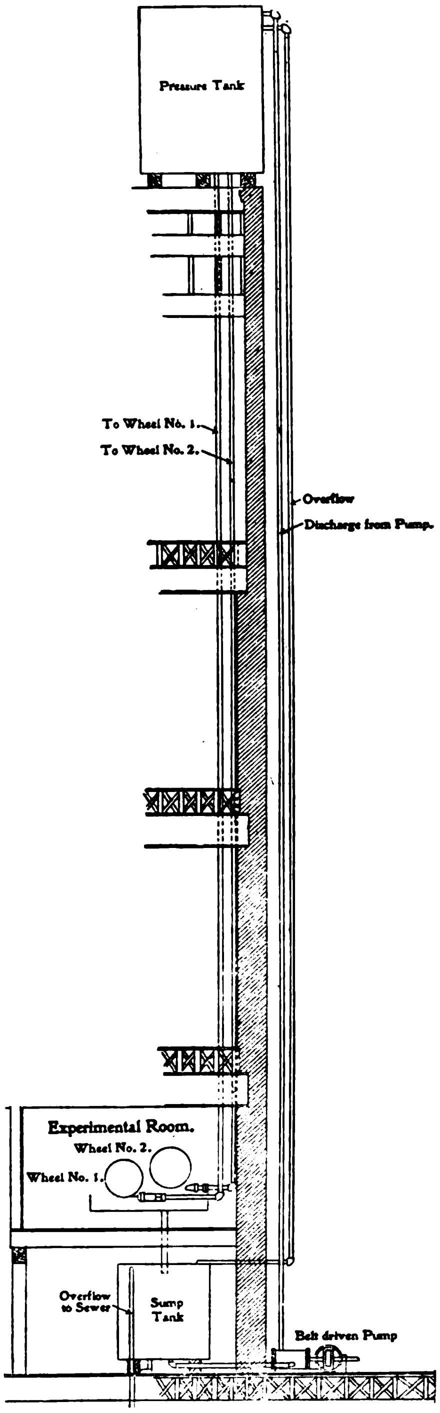

FIG. 2.—ARRANGEMENT OF APPARATUS.

This method of investigation, while giving the actual results obtained, was not sufficiently satisfactory in indicating how corrections or improvements in bucket design could be made, and it was therefore desired to introduce some method to discover the cause of certain irregularities in the bucket-efficiency curve. The measurement of the impulse pressure against the bucket when the wheel is stationary did not give any idea of what would actually occur when the wheel was rotating, and the high velocity at which it was necessary to rotate the wheel in order to approximate operating conditions made it impossible to determine visually what was taking place on the individual bucket surface.

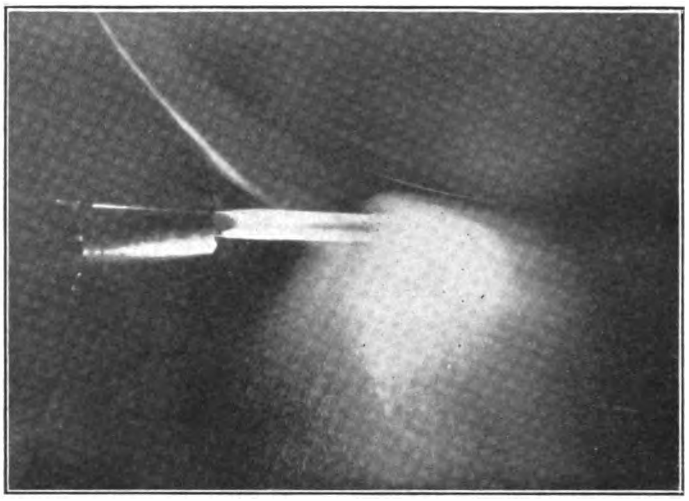
FIG. 3.—WATER DISCHARGE FROM BUCKETS.

A special shutter was therefore arranged, rotating in front of an arc lamp and admitting from the arc flashes of light in synchronism with the passage of the buckets. In other words, the entire rotating wheel is arranged to be illuminated by a flash from the arc lamp at the instant of time that each bucket passed a given point. The result of this to the eye is a stationary image of the wheel with the water being removed on traversing and discharged from the bucket surface exactly as it occurs in practice. It also eliminates from the vision everything that occurs on the bucket at any other instant of time. By displacing the position of the image and slightly moving the lamp, the condition of water impulse flow and discharge may be examined for a consecutive series of positions, and any crowding of water over any portion of the bucket surface, or any spattering that might occur due to the wrong angle of the entering lip, or any incorrect discharge angle, or discharge against the back of the bucket next following, can readily be observed and the changes in bucket surface to make the necessary correction deduced. Not only are the causes of known losses readily discovered by this means, but methods of improvements in bucket shapes become apparent by this method of investigation. In Fig. 1 the arc lamp and shutter case are shown at the right, and the 45-degree mirror by which the light is thrown on the buckets through the glass bottom of the wheel case may be noticed below the wheel.

This apparatus is in constant use by the Pelton Water-wheel Company for the determination of bucket shapes, and has resulted in obtaining much more reliable constants for use in the design of water-wheels than can be obtained by any other method thus far made known. It is adapted for use with any type of nozzle, and furthermore, the nozzle may be adjusted vertically. When the photograph of Fig. 1 was taken, a needle nozzle was used.

Some interesting photographs have been taken by this apparatus which show the effect of the stream on the buckets. Fig. 3, for example, was taken with the wheel revolving and shows the water being discharged from the buckets at almost zero velocity. Fig. 4 is an instantaneous view taken of the test wheel with the aid of the shutter when the wheel was running at high efficiency. It shows the discharge from the sides of the buckets to be parallel with the entering jet. The photograph also indicates that the front of the Pelton bucket enters the stream without shock or disturbance of any kind and that all of the energy is removed from the water by the shape of bucket being tested.

By the aid of the test wheels, the company has been able to design its buckets and wheels so as to give the highest efficiency, and the efficiency as experimentally determined in the test room, it is said, comes within 1 per cent. of the operating efficiency of the completed wheel after installation. The test apparatus is patented by the writer.

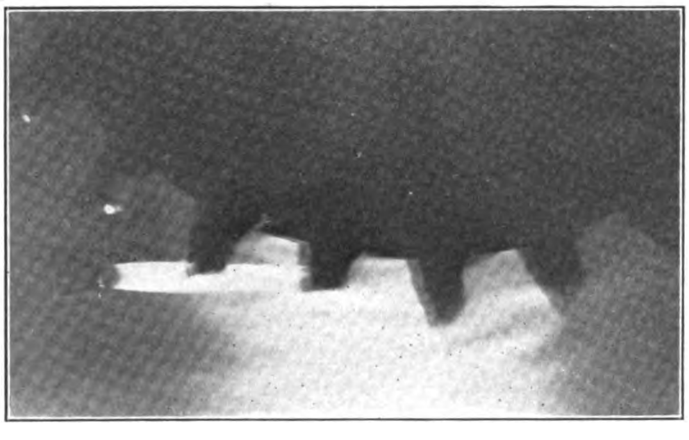
FIG. 4.—INSTANTANEOUS VIEW OF TEST WHEEL.

THE WIRING OF EXPOSED STEEL FRAME BUILDINGS.

BY ARTHUR B. WEEKS.

The accompanying sketches and the following notes as to ways in which wires are secured to steel beams and girders describe a favorite method of construction. In the wiring of steel buildings of the mill or machine-shop type, the wires are strung high up among the steel work; often porcelain knobs are merely tied to girders with soft iron wire, and the insulated line wires secured to them throughout the building. It may be that one circuit is for arc and another for incandescent lamps, with still another for motors. Fig. 1 shows a method of securing large conductors. Large knobs or cleats can be fastened directly to the top timber, which is virtually a cross-arm, or malleable iron or oak pins can be used, with screw glass insulators. Smaller wires can also be tied to the timber, if required. The cross-arm is selected according to the needed strength. The bolts for fastening may be either carriage or machine bolts and need not be larger than ½ inch.

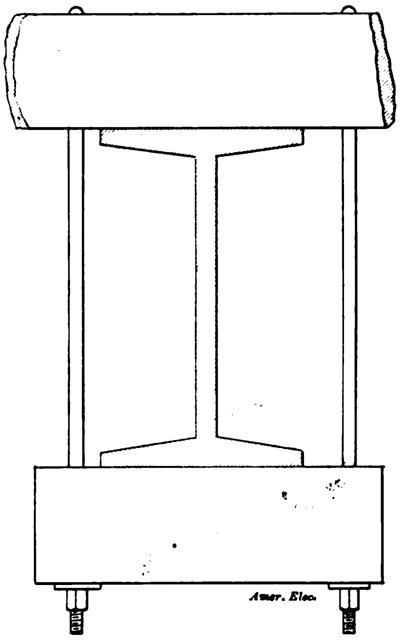

FIG. 1.

For similar work among smaller girders, the construction shown in Fig. 2 does very nicely. Should this method be followed for incandescent lighting, and individual cut-outs be used, they can be located on the cross-arm and the lamp cord dropped through a porcelain tube at the end of the arm. A better plan than using individual fused rosettes away up among the rafters is to control each circuit by a switch, and fuse it. In this case the wire for the drop lights must be of the same size as for the remain-

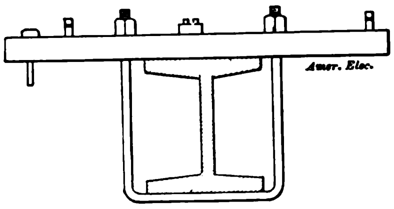

FIG. 2.

der of the circuit, which is ordinarily No. 14 B. & S.; if in a dry room and there is considerable drop, the hanging wires should be twisted. Cleats or porcelain insulators may be used to secure the horizontal wires, but the insulators are generally preferred in such cases. Two tubes will be required with this method, although a cleat could be used at the edge and side of the cross-arm to drop from.

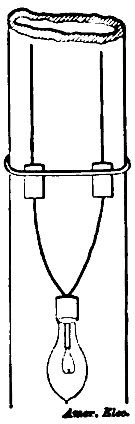

FIG. 3.

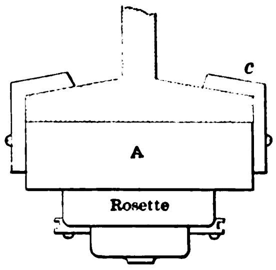

FIG. 4.

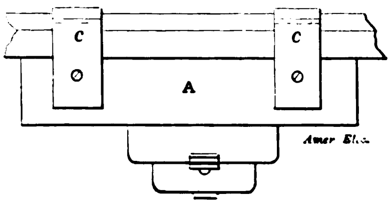

FIG. 5.

Should there be considerable moisture in the room, from leaky roofs, steam or damaged pipes, a method similar to that indicated in Fig. 3 is convenient, especially if the drop light is to light a lubricator or gauge. The insulators are tied by iron wire to the pipe, and the wires are let down through the insulators. Not enough care is used ordinarily in running light and power wires through damp rooms, especially in the vicinity of moving cables, tie rods, etc. Sometimes slack gets into wires which are run too close to elevator cables, and possibly the dampness of the place assists in the final open circuit. This open circuit is not always discovered by mere inspection for the insulation may remain nearly enough intact to retain the wires in place; so if the circuit is a long one, the best method of locating the trouble is to use a test lamp across the circuit until the break is found. Sometimes also weather-proof wire is used in localities so damp and so impregnated with steam that the insulating qualities of the best weather-proof covering will eventually be destroyed. For such places a good rubber core wire should always be used. Too often wires are run in places which are in the direct path of oilers, inspectors and others, with the result that they are soon pulled down upon the iron work, or torn entirely from their supports.

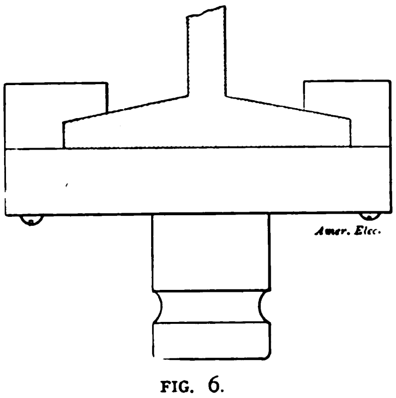

FIG. 6.

When cutting the cross-arms, they must be made long enough so that the wires will clear all tie rods, and the supports must be located close enough together to prevent sagging; if the spans are too long the wires may sag into contact with the iron work between the supports. By the proper spacing of the wires, many porcelain tubes can be eliminated. Some buildings, such as blast furnaces, for example, let in the rain or snow so that the liability to grounds or short-circuits always exists if the wiring is not properly done. Circuits in some such buildings have been found fused on one "leg" only. Common sense is a good thing to use in these cases, for not even the Underwriters' Rules can be a guide in every case. The National Code says: "Switches must not be single-pole when the circuits which they control supply devices which require over 660 watts of energy." This is all right in many cases, but what wireman has not found it advisable in places to use a double-pole switch for less than 600 watts?

Figs. 4 and 5 show a method of supporting lighting circuits along the under surfaces of I-beams. The wood support, *A*, is cut the desired length to take the rosette and cleat, and of a width the same as the face of the beam. The iron clamps, *c*, *c*, are 1 inch wide and ⅛ inch thick. They can be bent cold, and the wood support is held by them through wood screws. No screws are required elsewhere, of course. This plan is used throughout many factories of skeleton steel construction for supporting large power wires. For example, if the wires are 300,000 c. m. and the system is 440-volt, two-phase, the wood supports would be cut the width of the I-beam, and not only long enough for present needs but with allowance also for future circuits; the clamping irons would be 1 in. x ¼ in. with No. 12 wood screws, 1½ ins long. The porcelain single wire cleats should be spaced so that the wires are 4 inches apart. The I-beams will probably be about twelve feet apart, so that when properly pulled up, there will be no appreciable sag in the wires between supports.

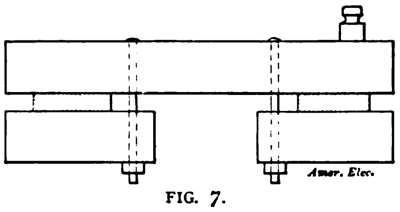

FIG. 7.

The method shown in Fig. 6 is sometimes used, but when it is used greater conveniences are usually at hand for cutting the wood to the proper bevel than are required for getting out the iron clamps. Fig. 7 shows a plan which is best employed in certain locations. The porcelain insulators are fastened in the usual way on top of the cross-arm, which is ordinarily 2 ins. x 4 ins. in cross-section.

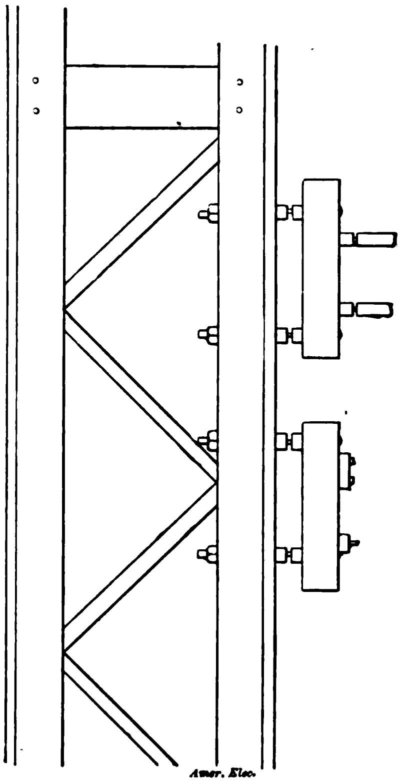

FIG. 8.

Where the wires are to be run along the side of a steel building, the arrangement shown in Fig. 8 is very good. The bolts pass through the space between the angle irons. If the building is not subject to dampness, there is no necessity for insulators between the wooden supports and the steel work. One of the supports may carry the fuse-block and switch, and the other the porcelain insulators for the line-wires. If there is more than ordinary heat in the vicinity of this line, slow-burning weather-proof wire should be used.

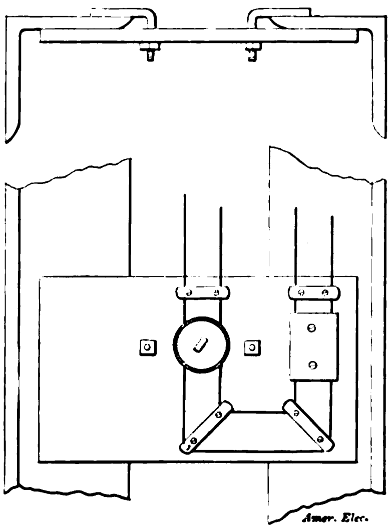

FIG. 9.

If it is desired to place a switch and cut-out for a lamp circuit within reach of the floor in a high steel building, a board can be fastened as shown in Fig. 9. Two ⅜-in. bolts are bent as shown in the upper sketch, and holes to take the bolts with a driving fit are drilled through the board. The wires may be fastened to insulators between the board and their upper connections in the way which best suits the case. Often four porcelain insulators can be tied separately to an iron brace and spaced properly side by side so that the wires can be run through the insulators. This is a quicker way than any others, and the effect is very neat.

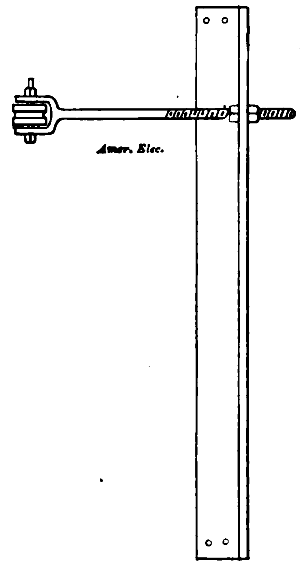

FIG. 10.

In some places, in channel iron columns, for example, blocks of wood can be driven in place with a hammer, so that no other mounting is necessary for a switch and fuse-block.

Fig. 10 shows one method of taking up slack in the bare trolley wires of a traveling crane. Any blacksmith can make the bolts, and the wire is tied to a porcelain insulator of the ordinary type shown. Turn-buckles are frequently used for this purpose and Brooklyn strain insulators are also employed. Usually four to six of these trolley wires are secured to the same angle iron, properly spaced, of course. There is one disadvantage when bolts are used as shown in Fig. 10 if they are exposed, as they frequently are, to the weather; after long standing the bolt becomes so rusty that it will twist off before the nuts move.

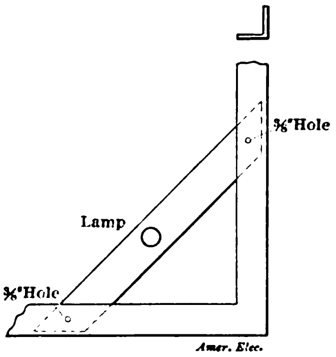

FIG. 11.

Fig. 11 shows a method of mounting an incandescent lamp to light the top of a blast furnace. A hand punch was used to make the ⅜-in. holes, and a piece of 2-in. x 4-in. scantling was placed across the corner as shown. A Newguard lamp was used and mounted on the scantling by means of a ½-in. crow-foot. Circular loom was used through the holes drilled in the scantling. The lamp had the customary rubber washes between the outer globe and its base to exclude moisture. There are times when no lamps or wires can withstand the flame and heat in such a location, so it is only a case of putting them up again should they be burned away. The wires are brought up to the top of the furnace along the most accessible route, and the one least liable to excessive heat. Porcelain insulators are tied to the steel work and the light wires are fastened to them, as already mentioned.

Sometimes it is necessary to punch holes through the corrugated sides of steel buildings to get a tie for insulators. In this manner, wires can be carried from one building to another without passing through intermediate buildings at all. In going from building to building in this manner, precautions should be taken against winter weather by having all wires very substantial, so that they can withstand the weight of accumulated and falling ice.

Lessons in Practical Electricity

ALTERNATING-CURRENT CIRCUITS.

The two parallel wires of alternating-current constant-potential circuits not only constitute a condenser (of very small capacity) but are of an inductive character, like the coil of an electromagnet, but in much smaller degree. This is due to the fact that the magnetic lines of force which encircle each wire when a current is passing (see Fig. 1) expand and collapse from and toward the center of the wire as the rapidly alternating current rises from zero to maximum and falls to zero again; in thus expanding and collapsing, the magnetic lines "cut" the conductor and induce an e.m.f. in it. If the wires of a given two-wire circuit are very close together, the magnetic circles produced by each wire encircle both of the wires and neutralize each other; if the distance between the two wires is a few inches, some of the magnetic lines from each wire encircle the other wire, as indicated in Fig. 2, and the inductive effect is partially neutralized, but not entirely. Therefore, the farther apart the two wires are located, the worse will be the inductive effect.

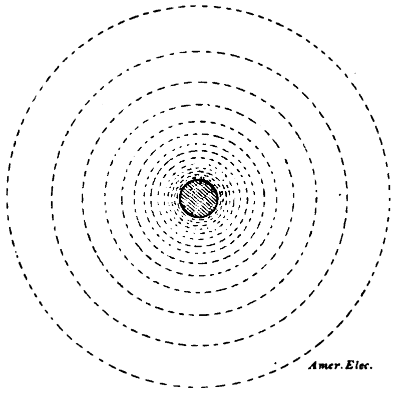

FIG. 1.

The e.m.f. thus induced in the line-wires opposes the e.m.f. which is applied to the circuit to force current through it, but not directly. The relation between the e.m.f. which overcomes the resistance of the wires and the inductive or reactive e.m.f. induced in them is exactly the same as that between two mechanical forces applied to a common object from directions at right angles to each other; the resultant of these two e.m.f.'s is the e.m.f. actually applied to the circuit. Fig. 3 illustrates this point. The horizontal line represents the e.m.f. expended in overcoming the ordinary resistance of the circuit wires; the vertical line indicates the reactive e.m.f. induced in the wires by the magnetic flux, as just explained. If these two lines are drawn to scale so that their relative lengths are the same as the relative volts that they represent, the diagonal line will represent, to the same scale, the volts that must be applied to the circuit in order to force through a current of such value as to cause the line resistance to use up the volts indicated by the horizontal line. For example, if the current is 10 amperes and the resistance of the two wires is two ohms, the "resistance e.m.f." or e.m.f. required to overcome the line resistance, will be 20 volts. Then if the reactive e.m.f. induced in the wires is 15 volts, the impressed e.m.f. necessary to force 10 amperes through the line will be

$$E_z = \sqrt{E_r^2 + E_x^2} = 25 \text{ volts.}$$

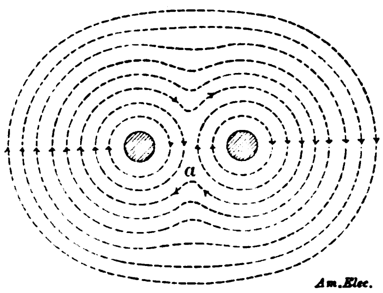

FIG. 2.

The circuit being inductive, the current in it will lag behind the applied e.m.f. in rising and falling, as explained in a previous lesson.

If the circuit supplies a group of incandescent lamps (which are non-inductive, of course) both the load and the circuit wires must be considered in ascertaining how much applied e.m.f. will be needed, but the total e.m.f. will not be the simple sum of the volts at the lamps and the impedance volts in the line. The volts required by the lamps must be added to the volts required by the resistance of the line, and a new triangle of forces constructed. Thus, if

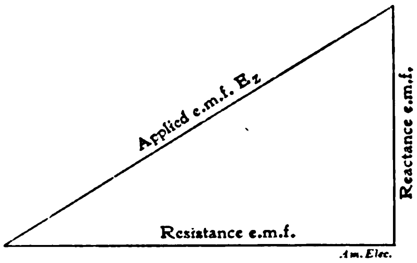

FIG. 3.

there are 20 lamps in the group, requiring 110 volts, the lamp current will be practically 10 amperes and the resistance volts of the line will be 20, as before; the horizontal line of the diagram, therefore, would be drawn to represent 110 + 20 = 130 volts.

TABLE I.

Power Factors and Inductance Factors.

Power Factor p	Inductance Factor q	Power Factor p	Inductance Factor q
.70	.7142	.85	.5267
.71	.7042	.86	.5103
.72	.6940	.87	.4930
.73	.6835	.88	.4750
.74	.6726	.89	.4560
.75	.6614	.90	.4360
.76	.6500	.91	.4147
.77	.6380	.92	.3920
.78	.6258	.93	.3675
.79	.6131	.94	.3410
.80	.6000	.95	.3123
.81	.5864	.96	.2800
.82	.5724	.97	.2430
.83	.5578	.98	.1990
.84	.5426	.99	.1410

The vertical line would remain as before, and the resultant diagonal would be as shown in Fig. 4; this would indicate an applied e.m.f. of

$$E_z = \sqrt{(E + E_r)^2 + E_x^2} = 130.86 \text{ volts.}$$

When the load is inductive, its resistance e.m.f. must be added to that of the line-wires and its reactive e.m.f. added to that of the wires; the sums of these will be the resistance e.m.f. and the reactive e.m.f. of the system as a whole, and the required applied e.m.f. is obtained from these two, as in the cases just explained.

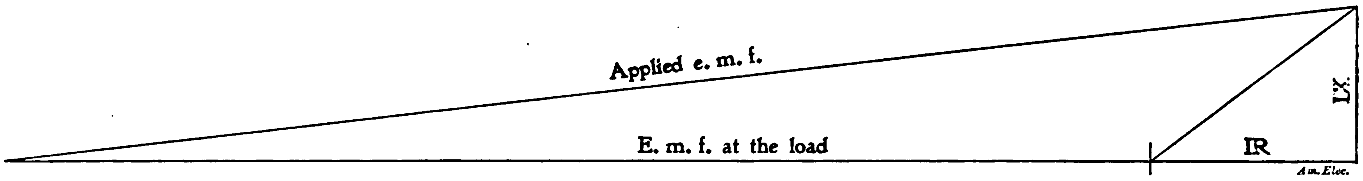

FIG. 4.

The resistance e.m.f. of an inductive piece of apparatus is ascertained by multiplying its rated e.m.f. by its power factor (see last month's Lesson), which is always specified by the manufacturer of the apparatus. The reactive e.m.f. is obtained by multiplying the rated e.m.f. by the "inductance factor" of the apparatus; the inductance factor depends on the power factor, being the sine of the angle of which the power factor is the cosine. (The student should take pains to avoid any notion of angles in currents and e.m.f.'s; angular functions are used in alternating-current mathematics as a matter of convenience, but there are no angles between actual e.m.f.'s and currents.) Table I herewith gives a list of inductance factors corresponding to different power factors.

The "resistance e.m.f." of a line is merely the resistance in ohms multiplied by the current that flows; the reactive e.m.f. is obtained by multiplying the line reactance by the current, but the reactance is not easily ascertained. Table II gives the inductive reactance of two parallel wires each 1000 feet long, at different distances apart and at the two frequencies mostly used in this country.*

From the foregoing, it follows that the e.m.f. required at the "starting end" of a two-wire line supplying a given load at the other end is

TABLE II.—Reactance of two parallel Copper Wires each 1000 Feet Long.

Wire Sizes.	Distance apart of the wires 3 ins.	6 ins.	9 ins.	12 ins.	18 ins.	
00	.1402	.1720	.1907	.2039	.2226	At 60 cycles.
0	.1456	.1774	.1960	.2093	.2279	
1	.1510	.1827	.2014	.2146	.2332	
2	.1563	.1880	.2067	.2199	.2386	
3	.1616	.1934	.2120	.2253	.2439	
4	.1670	.1987	.2174	.2306	.2492	
5	.1723	.2040	.2227	.2359	.2546	
6	.1776	.2094	.2280	.2413	.2599	
8	.1883	.2200	.2387	.2519	.2706	
10	.1989	.2307	.2493	.2626	.2812	
12	.2095	.2414	.2600	.2732	.2919	
00	.3116	.3824	.4238	.4532	.4946	At 133 cycles.
0	.3234	.3942	.4356	.4650	.5064	
1	.3353	.4060	.4475	.4768	.5183	
2	.3471	.4179	.4593	.4887	.5300	
3	.3589	.4297	.4712	.5005	.5420	
4	.3708	.4416	.4830	.5124	.5538	
5	.3826	.4534	.4948	.5242	.5656	
6	.3945	.4653	.5067	.5361	.5775	
8	.4182	.4889	.5304	.5598	.6012	
10	.4418	.5127	.5540	.5834	.6249	
12	.4655	.5363	.5777	.6071	.6485	

$$E = \sqrt{(E p + I R)^2 + (E q + I X_l)^2},$$

in which E is the e.m.f. at the load; p, its power factor; q, its inductance factor; I, the current it requires; R, the resistance of the circuit wires, and Xl, the reactance of the wires. The effective "drop" in the line wires is the difference between the applied e.m.f., Ez, and the e.m.f. E, at the load.

The capacity or condensance of a short line is so small as to be practically negligible, but on long lines it becomes a serious feature. Since the two wires act as the plates of a condenser, the farther apart they are, the less will be the condensance of the line; but since the inductance of the line increases as the distance between the wires is increased, it is not practicable to bring the condensance down to a negligible point by merely separating the line wires to great distances. It sometimes occurs that the condensive or capacity reactance (see last month's Lesson) equals the inductive reactance of the line; when this is true, the line is said to be in a condition of "resonance," and in that condition the current follows Ohm's law and the "drop" in the line is simply the product of line resistance and current.

Letters on Practical Subjects

Some Things We Need.

To the Editor, American Electrician:

Manufacturers of electrical supplies are generally quick to see and even to anticipate the need for various devices used by electrical contractors. There seems to be one very great deficiency, however, which we feel especially in Chicago, and I think likely has been felt elsewhere. This is in regard to ceiling rosettes for drop cords. The rules of the Electrical Inspection Department of Chicago, which are the same as the National Code, with a few additions, require drop cords to be soldered directly to the wires at a ceiling outlet. When the electrical contractor has to put in a drop cord with concealed work in this city, he finds that he must adopt some make-shift because of the lack of any porcelain ceiling rosette adapted to enclose a soldered joint. What is known as a self-tying seal button is all right for open work, but if used on concealed work, the taped joints must be left exposed, which makes the job so unsightly that it is not allowable in ordinary residence or office wiring. An ordinary fusible porcelain rosette can be used by breaking out the partition on the base and tucking away the soldered joint in the small space within the rosette. This, however, is a make-shift, as the wires are crowded and the rosette was never intended to take a soldered joint. Another way out of the difficulty which has sometimes been used is to put a keyless socket or receptacle on the ceiling and to attach the drop cord to it by means of an extension plug. This, however, is purely a make-shift and it is difficult to see why, if a drop cord is to be permitted on an extension plug, with binding posts on the plug, it is not equally permissible to connect the drop cord into the binding posts of a fuseless rosette in the first place and do away with the plug and socket. The one really workman-like solution of the question seems to be to purchase a small fixture canopy with a wooden ceiling block which will just fit the canopy and to which the edge of the canopy can be fastened by screws. The canopy allows plenty of room to conceal a soldered joint between the cord and wire, and the wooden block insulates the whole thing from the ceiling. But why should we be obliged to do this for lack of the right kind of porcelain rosette? Why cannot manufacturers make a two-piece porcelain rosette without binding screws and with plenty of room to conceal the soldered joint? Such a rosette should consist of two pieces, a simple flat disc of porcelain for a base, and a cap with room in it for a joint and a knot in the cord. The rosette could be fastened to the ceiling by a pair of wood screws going through both pieces. This would make a simple, neat and substantial job. There may be some such rosette on the market somewhere, but if there is, it is not in evidence in manufacturers' catalogues or in Chicago supply stores, where of all places it should be kept on sale.

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* The formula is $2 \pi f L = X$; and $L = 1400 \times$ *length in feet* $\times (0.10857 + \log \frac{d}{r}) \div 10{,}000{,}000{,}000$; d = distance apart; r = radius of wire cross-section.

Another little device which ought to find an extensive sale if once users of electric light were shown its convenience, is a small clamp with socket attachment whereby an incandescent lamp could be clamped on each side of the mirror of an ordinary dresser. A pair of lamps could be easily clamped on each side of the mirror of each dresser and attached to existing fixtures or wall receptacles by means of extension cords and plugs. The arrangement would be almost ideal. At present if a man wants a light on each side of a mirror he must either put in two wall brackets or put some extra woodwork on the dresser on which to mount sockets.

Chicago, Ill. C. R. James.

A Problem in Motor Connections.

To the Editor, American Electrician:—

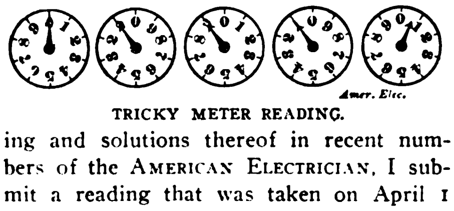
I have two series-wound motors, each wound for 110 volts and operated reversing. Two circuits are available for supplying the motors, one during one part of each day and the other during another part, so that the motors have to be shifted from one circuit to the other; one of the circuits supplies current at 110 volts and the other at 220 volts (not three-wire). The problem is to provide connections and switches between the two motors and the two circuits so that the motors may be operated on either circuit. When on the 220-volt circuit they must, of course, be connected in series with each other, and in parallel on the 110-volt circuit. It must be remembered that both motors are reversing machines. The wiring and switches must, of course, involve the most economical use of material, and be thoroughly practical; no specially designed switches which must be made to order can be used. I should like very much to have readers of the American Electrician suggest solutions of this problem.

Brookline, Mass. E. S. Lincoln.

Another Tricky Meter Reading.

To the Editor, American Electrician:—

Noticing Mr. Ryder's tricky meter reading and solutions thereof in recent numbers of the American Electrician, I submit a reading that was taken on April 1 which is not bad as a subject for consideration.



TRICKY METER READING.

Macon, Mo. Chas. Bennett.

[Solutions of Mr. Lincoln's problem and Mr. Bennett's meter reading intended for publication in the July number must reach this office not later than June 18. No solutions will be published in the August number. Readers desiring to submit solutions for criticism but not for publication are cordially invited to do so.—Editor.]

Voltage Disturbances from Paralleling Dynamos.

To the Editor, American Electrician:—

I noticed in your April number a letter from Mr. Ernest F. Hartwell in which he states that he has trouble from voltage fluctuations when connecting a generator to the bus-bar in parelle1 with operating machines. He did not say whether his generators were compound-wound or not, but I presume they are; from his description of his trouble, I also presume that each generator is controlled by a single triple-pole switch. If this is true, there is no wonder that the voltage fluctuates when machines are thrown into circuit. In order to avoid this and other disadvantages incident to the use of a single switch for all three terminals of a compound-wound generator, I have for many years followed the practice of using three single-pole switches for each generator, one in the positive lead, one in the negative, and the other in the equalizer lead. When a machine is to be thrown in, the positive and equalizer switches are thrown in first (the series winding is on the machine) and the machine is adjusted to the voltaage of the busbars by means of the shunt-field rheostat. Its series field being already parallel with the series windings on the active generators, there is no disturbance whatever when the third (negative) switch is closed to put the machine in parallel with its mates. The rheostat has to be readjusted slightly after the machine is connected in, but there is no disturbance of the bus-bar voltage. I suggest that Mr. Hartwell try this method of connecting up.

Fred P. De Wilde.
Butte, Mont.

[Mr. De Wilde's letter was received just as last month's issue was going to press, so that it could not be inserted in that number. The method he describes is quite widely used, except that the equalizer lead and the main lead on that side of the machine are connected to a double-pole switch instead of two single-pole switches; the results are exactly the same.—Editor.]

Wiring for Bells in Parallel.

To the Editor, American Electrician:—

I enclose three diagrams of bell connections for eight 5-in. vibrating bells located on eight floors and rung simultaneously from the ground floor. One friend contends that the proper way to connect the bells is in pairs, as shown in Fig. 1, ringing them one pair at a time. Another says that Fig. 2 is the best way to arrange the circuits in order to economize in material, insure reliable ringing and entail the least amount of trouble in signaling; the extra feed wire is to equalize the voltage at the bells and prevent the bells nearest to the battery from taking most of the current, and the use of a single push-button reduces the trouble of ringing to a single operation. The writer favors the simple method shown in Fig. 3. Which of the three is the best way to connect up? I should like to have expressions of opinion from you and readers of the American Electrician.

Chicago, Ill. R. B. Burton.

[Theoretically, Fig. 2 is preferable, but if the main line-wires are of sufficient cross-section and the bell magnets of sufficiently high resistance, Fig. 3 will give entirely satisfactory results. It might be advisable to connect the batteries in series-parallel to avoid drawing excessive current from the cells, but with high-resistance bell magnets this would not be necessary.—Editor.]

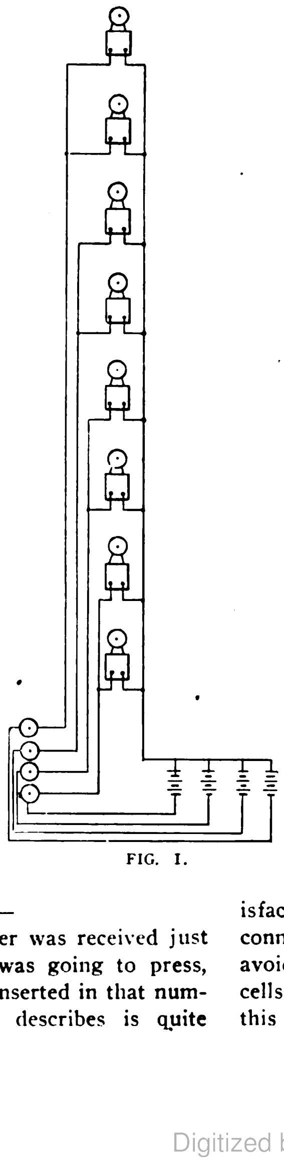


FIG. 1.

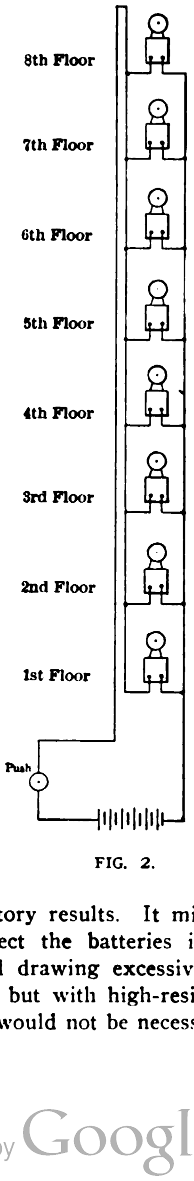


FIG. 2.

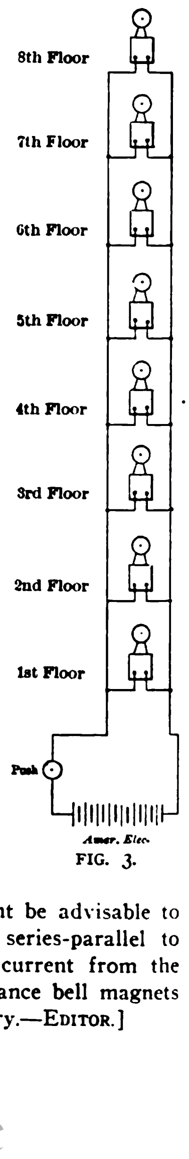


FIG. 3.

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

What brand of steel is best suited for the permanent magnets in telephone apparatus and magneto generators? A. D.

Tungsten steel. Chrome steel is also good.

Where can I get the castings for the voltmeter or ammeter described in the December, 1903, number? D. S.

Probably from J. C. Brocksmith, 488 Douglass Boulevard, Chicago.

Is not paraffine injurious to copper wire, or can the paraffine be made free from acid? (2) Please give data for a 6-in. spark coil. O. S.

No; it is free from acids. (2) We have no data for such a coil. "Electrical Designs" contains data for a 6-in. induction coil, if that is what is meant. The price is $2.

How can the power factor of an alternating-current multiple arc lamp be controlled in the construction of the magnets and choke coil? A. A. J.

The higher the resistance of the windings in comparison with their inductance, the better will be the power factor, but the lower will be the efficiency of the lamp; a compromise between the two is necessary.

What is the easiest practical way to change a 500-volt 15-h.p. 4-pole motor, with a two-path winding and two sets of brushes, so that it will work on a 220-volt circuit? J. E. McH.

Disconnect one armature coil and "dead-end" its terminals; bridge together two of the commutator bars at the point where one of the terminals of the discarded coil was connected, and connect up the remaining coils lap fashion. Add two more sets of brushes and connect the field winding in series-parallel.

How should the armature coils be wound and connected in a 12-pole, 12-coil alternator, the coils being of the pan-cake type? The machine is not compound-wound. G. A. B.

The coils may be all wound alike and the connections should be such that if direct current were sent through the armature it would circulate in opposite directions in any two neighboring coils. The coils may be all in series or connected in two parallel groups of six coils in series, according to the voltage desired.

Is it practical to operate ordinary telephone outfits on a grounded line 3000 feet long, with an intermediate station 750 feet from one end of the line, using dry batteries; if so, how many cells of battery should be used? (2) What size and kind of wire should be used? A. L. S.

Yes. Use the simple bridging sets, with a talking battery of two cells at each station, and magneto signalling apparatus. If battery signalling is essential, four or five cells and a push-button may be substituted for the magneto generator at each station. (2) No. 12 galvanized iron telegraph wire will answer, but No. 14 copper would be much better.

I have built a small motor with a gramme ring armature, but fail to get any results. The field magnet is strong, but the armature shows no magnetism when connected up to the circuit. What is the trouble? (2) Can dry batteries be used to supply three 6-c.p. incandescent lamps satisfactorily? W. H. R.

If your armature winding is connected to the commutator properly the trouble may be that the coils are not all wound in the same direction; they should all be exactly alike and the starting end of each coil should be connected to the final end of the next coil and to a commutator segment. (2) No; the battery renewals will be excessive.

How many turns of No. 30 magnet wire will be required for the voltmeter described in the December number to give full scale deflection at 10 volts? (2) How many turns and what size of wire will be necessary to wind the instrument as an ammeter giving full scale deflection at 5 amperes? (3) Will a water rheostat with round plates 8 ins. in diameter and 7 ins. apart have enough resistance to take up 70 volts with 5 amperes passing? H. M.

No. 30 wire cannot be used for such a low voltage; use No. 20 wire and put in as many turns as the bobbin will hold. (2) 130 turns of No. 12 wire. (3) Yes, but it will be much better not to limit the maximum distance between plates to 7 inches; 10 or 12 inches would be better for general use.

A three-wire circuit shows abnormal drop when the load comes on, so that the proper e.m.f cannot be maintained at the center of distribution, though the generators are strengthened to more than 20% above the rated voltage; what is the probable cause? (2) Why are automatic speed regulators not used on automobile engines? H. C. K.

The circuit wires are very much too small for the load or else one of your generators has reversed and the neutral wire is carrying a current equal to the sum of the currents in the outside wires. An ammeter in the neutral wire will show whether or not the latter is the case. (2) Because it is desired to operate the motors at widely different speeds; the change gears only give two or three speeds, intermediate gradations being obtained by varying the speed of the motor.

How can I figure the horse-power in the cylinder of an engine driving a dynamo which supplies 26 arc lamps requiring 50 volts each and 20 lamps requiring 75 volts each? All of the lamps take 6½ amperes. (2) How many amperes are equal to one horse-power? R. J. M.

You can't, unless you know the mechanical efficiency of the engine and the commercial efficiency of the dynamo. The dynamo will be supplying approximately $26 \times 50 \times 6\frac{1}{2} + 20 \times 75 \times 6\frac{1}{2} = 18{,}200$ watts, which are equal to about 24.3 horse-power; to this must be added the mechanical losses in the engine and all of the losses in the dynamo in order to ascertain how much horse-power is being developed in the engine cylinder. (2) Horse-power cannot be expressed in terms of amperes; multiplying amperes by volts will give the watts in a direct-current circuit, and dividing the watts by 746 gives the horse-power.

If the engine and generator of a direct-connected set reach full load simultaneously, how much overload can be given the generator without overloading the engine to a dangerous extent? (2) If the overload limit of the engine be exceeded, what will happen? (3) What range of cut-off does the ordinary automatic shaft governor give the valve? (4) If an engine having such a governor be designed for 350 r.p.m., how can the speed be reduced to 300 r.p.m.? E. B.

The question resolves simply into "What is the overload capacity of a dynamo, and what that of an engine?" The answer can only be given by the manufacturers of the dynamo and engine. (2) Either something will give way or the engine will slow down; usually the latter. (3) From zero to half stroke, on a single-eccentric engine and to about 0.7 of the stroke on a double-eccentric engine. In practice, the cut-off of a double-eccentric engine is rarely later than 0.65 of the stroke. (4) By reducing the tension of the governor spring or springs; if the weights are adjustable on their arms, they should be moved a trifle toward the free ends of the arms.

Two 125-volt 150-kw. direct-current generators operated on a three-wire system (one on each side of the neutral) give trouble from excessive voltage at full load; when the load reaches about 80% of full load, all of the rheostat is in circuit. The commutator and the bearing at the commutator end get extremely hot. What remedies would you suggest? The two machines are driven in tandem from a single driving pulley, and one of them runs hotter than the other regardless of the division of the load. F. M. L.

Adjust the shunt strips at the terminals of the series field windings until the machines compound properly without the manipulation of the rheostats; the strips must be shortened, so as to shunt more current away from the windings. The commutator heating may be partly due to the bearing, but is largely due either to too heavy tension at the brush springs or to insufficient contact area at the brush faces. The heating of the bearing may be due to roughness in the sleeve, improper operation of the oil rings, or insufficient clearance between the shaft diameter and the sleeve bore; the actual cause can be determined only by careful inspection.

How is the reading of a recording ampere-hour meter reduced to watt-hours? (2) What is a "constant" and how is it ascertained? (3) Is there any difference between frictional, dynamic and voltaic electricity? (4) Can the discharge of a condenser or a Leyden jar be measured while it is occurring? C. W. F.

Multiply the reading by the voltage of the circuit. (2) A constant is a factor or a number representing two or more factors which do not change; it is also a ratio between different systems of units. Thus, in a long formula containing several factors which always have the same values, these factors may be represented by a "constant" and the formula thereby simplified. Again, a dimensional formula expressed in metric measure may be made to express the same relations in English measure by inserting a "constant" which covers the ratios between the metric units and the English units. (3) Not qualitatively. The chief differences are in the magnitude of the voltage and current; static electricity is always at enormous potentials and the current of a static charge or discharge is extremely small compared with voltaic and dynamic electricity. The two latter differ chiefly in the magnitude of their voltages, but not so greatly as both differ from frictional or static electricity. (4) No; it occurs too quickly to be measured directly.

HIGH-VOLTAGE OIL SWITCHES.

The high-voltage switches made by the Stanley Electric Manufacturing Company of Pittsfield, Mass., are designed to break the circuit simultaneously at several points, so as to distribute the resulting disturbance over a considerable area. For potentials above 6600 the various contacts are arranged in the same horizontal plane so that the disturbances resulting from the arc are distributed rather than concentrated. This also has the advantage that the arc tends to flare upwards, increasing its length and thereby securing a longer break.

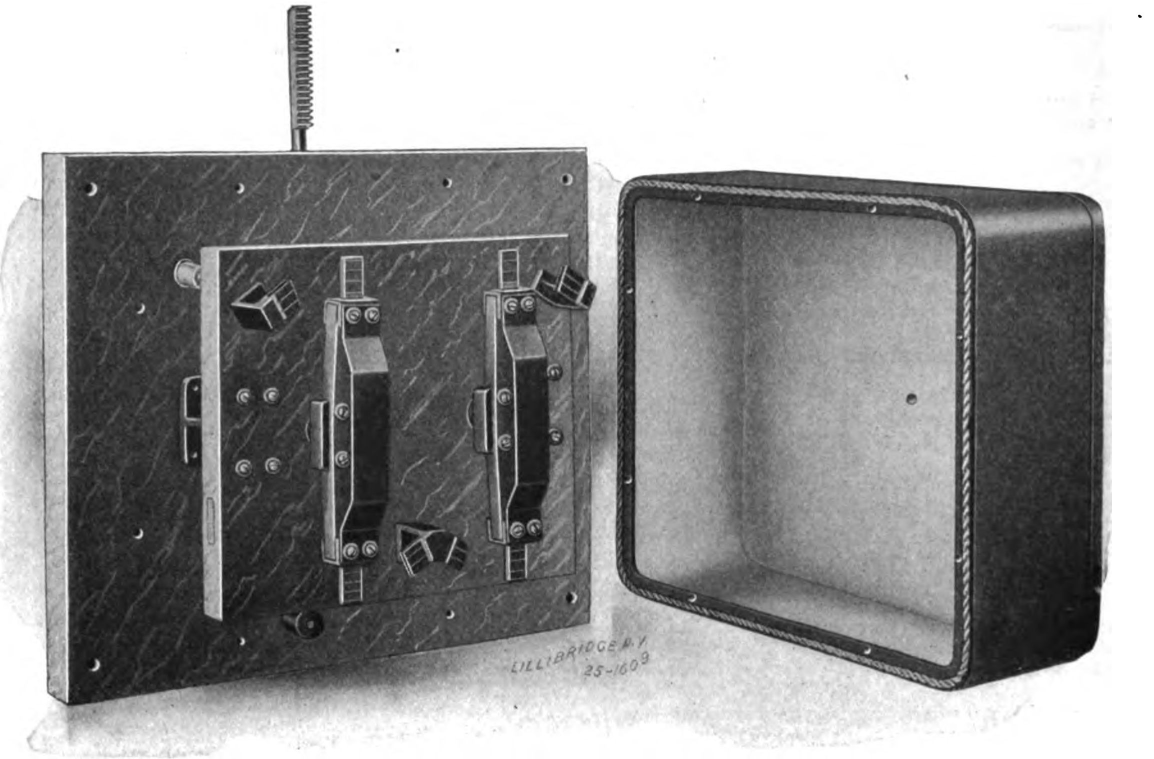


FIG. 1.—ONE POLE AND TANK OF 15,000 VOLT OIL SWITCH.

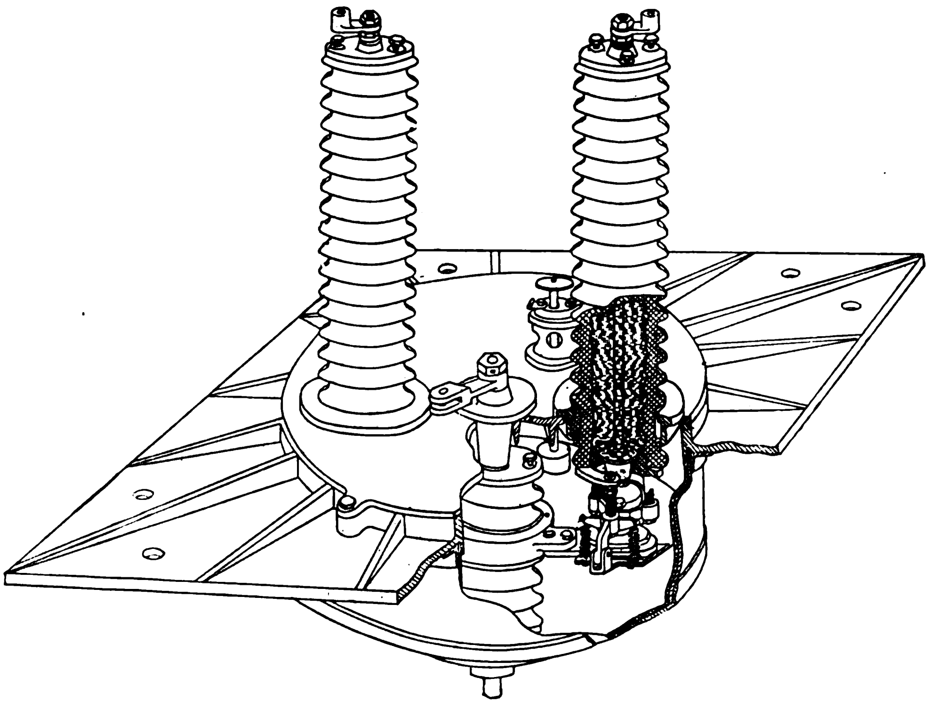


FIG. 2.—60,000-VOLT OIL SWITCH.

The contacts are located comparatively near the surface of the oil, so that the escaping gases are readily dissipated. These principles of construction are embodied in the new 300-ampere 60,000-volt switch recently brought out by the company. Fig. 2 gives a good idea of the construction of the switch. Each pole consists of, first, a cast iron top or mounting plate, on which are mounted the top terminal contact insulators, a bearing of liberal length for the driving shaft, and a combined gas vent and automatic oil level indicator; and, secondly, a tank filled with oil in which are immersed the contacts suitably insulated. The insulators are of porcelain made in the form of corrugated cylinders. The center insulator carrying the contact blades is entirely immersed in oil. The two terminal insulators are partly filled with and have their lower ends immersed in oil. These two insulators are held in position by means of hollow clamp rings which are fastened to the insulators with set-screws and cement. The contact blades are fastened to the central insulator in a similar fashion.

Fig. 3 shows the details of a contact. The contact arms are of hard-drawn flat copper strips. Each fixed contact is forced downward by three coiled springs which are carried on the studs on which the fixed contacts slide, and which are screwed on the bottom of the insulator. These fixed contacts, as well as the blades, have ground surfaces. On closing the switch, each contact blade slides under the corresponding fixed contact, and, owing to the arrangement of the springs, a self-aligned contact results.

The shape and position of the shunt or arc-rupturing contacts are said to be such as to prevent any possibility of the arc being taken by the main contacts. These auxiliary contacts are readily replaceable. In the illustration, the oil level indicator can be seen on the left of the insulator, the construction of which is exposed. Should

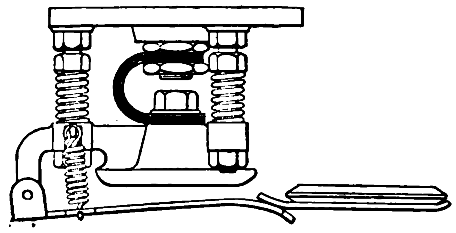


FIG. 3.—DETAILS OF CONTACT.

the oil leak out, or, for any other reason, recede below a safe level, the indicator closes the pilot circuit and warns the attendant by ringing a bell or lighting a lamp, as may be desired.

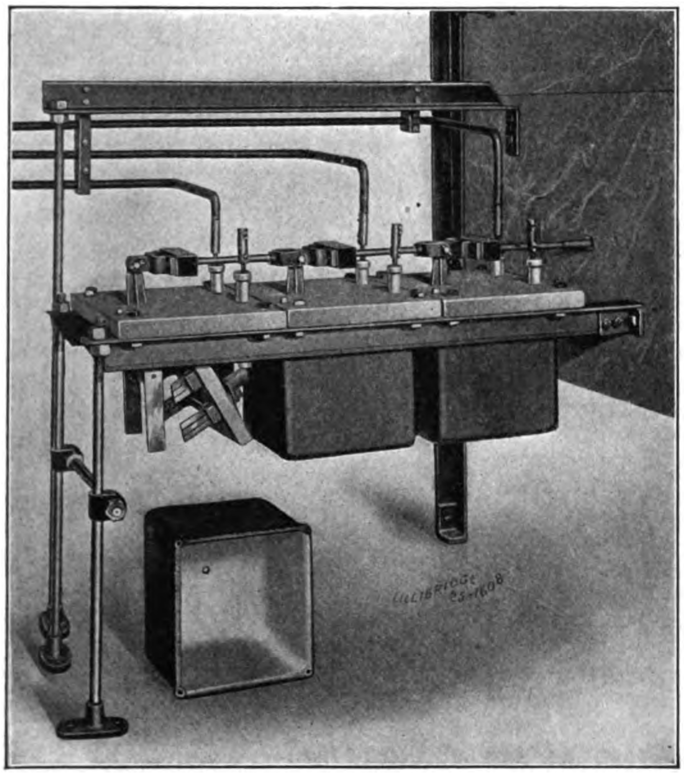


FIG. 4.—6600-VOLT THREE-POLE OIL SWITCH.

Each switch is tested and, in installing, the iron top and tanks are grounded, making it safe for the operator to handle the controlling device. The three-pole switch is made up of three of the units connected by rods, and the crank on each operating shaft is connected to either a motor, magnet or hand operated controlling device. The operation of either of these devices may be controlled by plain overload, time relay overload or reversed current relays. Each pole of the switch may be mounted in either a soapstone or brick compartment or upon iron framework.

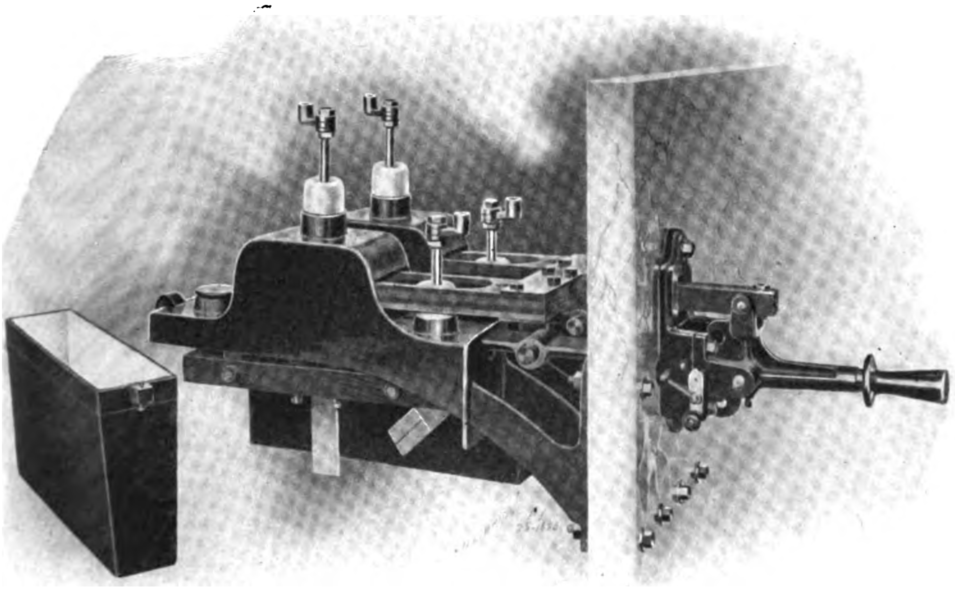


FIG. 5.—TWO-POLE TYPE "E" OIL SWITCH.

Fig. 1 shows one pole with tank of a 15,000-volt switch. As the contacts are arranged in series, it is evident that the circuit is broken simultaneously at four places, thus distributing the disturbance, as already noted. By connecting the two contact arms in parallel the switch has twice the carrying capacity, with half the breaking distance, and thus becomes suitable for currents of 200 amperes at 7500 volts. This type can also be used for 75 amperes at 20,000 volts, by changing the insulation carrying the leads.

This switch is also made double throw, another set of contacts being placed diametrically opposite those shown in the illustration. The tanks may be mounted either one above the other or in tandem, as may be preferred, or may be placed directly behind the board, or wherever convenient, and operated from the switchboard by means of connecting rods. This switch may, if desired, be equipped with circuit breaker attachment.

Fig. 4 shows a three-pole oil-switch for voltages up to 6600, and for currents up to 100 amperes. Each pole is in a separate tank and the tanks are mounted in a strong framework. The switch is made with circuit-breaker attachment, if so desired, and either single or double throw. One tank can be used as a double-pole switch with a capacity of 100 amperes at 2400 volts, by connecting one blade to each pole. By connecting the blades in parallel, instead of in series, the switch may be used for 200 amperes at 4000 volts. It is thus evident that this type of switch is readily adapted to meet a wide range of conditions.

Fig. 5 shows a type "E" oil switch, which is designed for installations of not over 3500 volts. It is made either single or double throw and for any number of poles desired. The normal three-phase capacity of the switch is 400 kilowatts and the emergency three-phase capacity is 1200 kilawatts.

The switch can be furnished with automatic, overload opening device. When so furnished, the handle for closing the switch is not connected rigidly to the parts making contact, but is latched thereto, the arrangement being such that it is impossible to close the switch when there is an overload or short circuit on the line. When these switches are furnished with this overload feature, series transformers are also supplied, but one being necessary for either a single-pole or two-pole switch and two for either a three-pole or four-pole switch. As in the company's switches for higher voltages, there is a separate tank for each pole.

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ELECTRICAL EXHIBITORS AT THE ST. LOUIS EXPOSITION.

The rapid advancement made in every line of invention since the Chicago Exposition provides a field of marvels for exhibition at St. Louis which will be at once remarkable and interesting. Following is a list of electrical exhibitors at the exposition, furnished by Prof. W. E. Goldsborough, chief of the department of electricity. The exhibitors from foreign countries, it will be noted, are not included:

Adams-Bagnall Electric Company, Cleveland; A. S. Aloe, St. Louis; American Carbon & Battery Company, St. Louis; American Circular Loom Company, Chelsea, Mass; American Electric Fuse Company, Chicago; American Electrical Heater Company, Detroit; American Electrical Novelty & Manufacturing Company, New York; American School of Correspondence, Chicago; American Telephone & Telegraph Company, Boston; the American Watchman's Time Detector Company, New York; American Watchman's Time Detector Company, Cleveland; Bion J. Arnold, Chicago; Association of Edison Illuminating Companies, Chicago; Martin Armstrong, St. Louis; Atlanta Utility Works, East Point, Ga.; the Automatic Electric Company, Chicago; Automatic Fire Alarm Company, New York City; Argentine Republic.

Baird Manufacturing Company, Chicago; Carl Bajohr, St. Louis; Bario Vacuum Company, New York; M. V. Barlow, Chicago; W. M. Bashlin, Warren, Pa.; Mrs. Alexander Baumgart, New York City; Benjamin Electric Manufacturing Company, Chicago; The Bristol Company, Waterbury, Conn.; The Browning Company, Milwaukee; The Bryant Electric Company, Bridgeport, Conn.; Bullock Electric Manufacturing Company, Cincinnati; Burdette-Rowntree Manufacturing Company, Chicago; Burnham-Williams & Co., Philadelphia.

H. B. Camp Company, Chicago; Carbondale Machine Company, Carbondale; Cassidy & Son Manufacturing Company, New York; Carman Projector & Specialty Company, Chicago; Central Telephone & Electric Company, St. Louis; Chicago Fuse Wire & Manufacturing Company, Chicago; Colonial Sign Company, Akron, Ohio; Chicago X-Ray Company, Chicago; James Clark, Jr., & Co., Louisville; A. Frederick Collins, New York; Commercial Electric Company, Indianapolis; Controller Company of America, St. Louis; Cooper Hewitt Electric Company, New York; Crocker-Wheeler Company, Ampere, N. J.

The Dayton Autoelectric Company, New York City; De Forest Wireless Telegraph Company, New York; Patrick B. Delany, South Orange, N. J.; The Dayton Electrical Manufacturing Company, Dayton, Ohio; Dialt Motor Company, Philadelphia; Dicke Tool Company, Downers' Grove, Ill.; Dodd & Struthers, Des Moines, Iowa; S. R. Dresser, Bradford, Pa.

Economical Electric Lamp Company, New York; Thomas A. Edison, Orange, N. J.; Electra Water Purifier Company, St. Louis; Electric Circulator Company, Chicago; Electric Contract Company, New York; Electric Controller & Supply Company, Cleveland, Ohio; Electric Railway Equipment Company, Cincinnati; Electric Storage Battery Company, Philadelphia; Eureka Tempered Copper Works, North East, Pa.

Faller Automatic Telephone Exchange Company, New York; Federal Electric Company, Chicago; C. J. Field, New York; Fort Wayne Electric Works, Fort Wayne, Ind.; France.

Germany; The Gardner Electric Drill & Machinery Company, Cleveland; General Electric Company, Schenectady, N. Y.; Gervais Manufacturing Company, Edgewater, N. J.; G. M. Gest, Cincinnati; W. E. Goldsborough, Lafayette, Ind.; Gould Coupler Company, New York; Gould Storage Battery Company, Depew, N. Y.; Gray National Telautograph Company, New York; Gray Telephone Pay Station Company, Hartford, Conn.; A. Grothwell, San Francisco, Cal.

C. F. Hall, Chicago; Robert E. Haward, Kansas City, Mo.; The Heinze Electric Company, Lowell, Mass.; Hellesens, Enke & V. Ludvigsen, Copenhagen, Denmark; Hinton & Tarkington, Hot Springs, Ark.; Holmes, Booth & Haydens Company, New York; Holophane Glass Company, New York; C. W. Hunt, West New Brighton, New York; Miller Reese Hutchison, New York City; Hutchison Acoustic Company, New York.

Italy; Indiana Novelty Company, Muncie, Ind.; International Acheson Graphite Company, Niagara Falls, N. Y.; J. Van Inwagen, Momence, Ill.

The Jackson Electric Drill & Supply Company, Denver, Colo.: The Jandus Electric Company, Cleveland.

Charles Kaestner & Co., Chicago; Kellogg Switchboard & Supply Company, Chicago; Kester Electrical Manufacturing Company, Chicago; Keystone Electrical Instrument Company, Philadelphia; The Kny-Scheerer Company, New York; H. E. King, Chicago; D. A. Kusel Telephone & Electric Manufacturing Company, St. Louis.

The Leclanche Battery Company, New York; Lincoln Electric Company, Cleveland; Lionel Manufacturing Company, New York; Locke Insulator Manufacturing Company, Victor, N. Y.

Mexico; McGraw Publishing Company, New York; McRoy Clay Works, Chicago; Marshall-Sanders Company, Boston; W. E. Matthews & Brother, St. Louis; The Miller Anchor Company, Norwalk, Ohio; Mystic Electric Gas Lighter Company, New York; Moloney Electric Company, St. Louis.

National Carbon Company, Cleveland; National Battery Company, New York; National Cash Register Company, Dayton, Ohio; National Electric Company, Milwaukee, Wis.; Nernst Lamp Company, Pittsburg; National Clock Works, St. Louis; Northern Electrical Manufacturing Company, Madison, Wis.; Norton Emery Wheel Company, Worcester, Mass.; Nungesser Electric Battery Company, Cleveland.

The Organ Power Company, Hartford, Conn.

Pawling & Harnischfeger, Milwaukee, Wis.; The Peerless Electric Company, Warren, Ohio; Perkins Electric Switch Manufacturing Company, Bridgeport, Conn.; The Phelps Company, Detroit, Mich.; Walter P. Phillips, Bridgeport, Conn.: Pittsburg Blue Print Company, Pittsburg; Pneumatic Signal Company, Rochester, N. Y.; Postal Telegraph Cable Company, St. Louis; Printing Telegraph News Company, St. Louis; Prometheus Electric Company, New York City; Produce Research Laboratory, Lafayette, Ind.; Portugal.

Queen & Co., Philadelphia; F. Herrero y Ruix, Albacete, Spain.

Reynolds Electric Flasher Manufacturing Company, Chicago; The Robbins & Myers Company, Springfield, Ohio; Chicago Röntgen X-Ray Laboratory, Chicago; Roth Brothers & Co., Inc., Chicago.

St. Louis Brass Manufacturing Company, St. Louis; the Safety Insulated Wire & Cable Company, New York; Sawyer-Man Electric Company, New York; W. Scheidel & Co., Chicago; M. Shearer, Akron, Ohio; Shedd Electric & Manufacturing Company, New York; Standard Underground Cable Company, Pittsburg; Standard Water Purifying Company, Cleveland; Sterling Electric Company, New York; Sterling Electric Motor Company, Dayton, Ohio; S. W. Stratton, Washington, D. C.; William F. Stilz & Co., Philadelphia; Sumter Telephone Manufacturing Company, Sumter, S. C.

Telephone Hygienic Company, Los Angeles, Cal.; C. H. Thordarson, Chicago; C. J. Toerring Company, Philadelphia; Triumph Electric Company, Cincinnati, Ohio.

Underwriters' Laboratories, Chicago; U. S. Incandescent Lamp Company, St. Louis; United States Electric Signal Company, West Newton, Mass.

E. C. Van Nort Electric Company, St. Louis.

Wagner Electric Manufacturing Company, St. Louis; R. V. Wagner & Co., Chicago; Waite & Bartlett, New York; Warren Ball-Bearing Fixture Company, New York; Warren Electric & Specialty Company, Warren, Ohio; Warren Electric Manufacturing Company, Sandusky, Ohio; B. F. Wasson, Clinton, Ill.; Western Electric Company, Chicago; Wesco Supply Company, St. Louis; *Western Electrician*, Chicago; Western Union Telegraph Company, St. Louis; Weston Electrical Instrument Company, Newark, N. J.; Westinghouse Electric & Manufacturing Company, Pittsburg; Wheel Truing Brake Shoe Company, Detroit, Mich.; Windsor & Kenfield Publishing Company, Chicago; Wireless Railway Company, Philadelphia; Westinghouse Traction Brake Company, New York; The Wyckoff Pipe & Creosoting Company, Stamford, Conn.

Charles E. Yetman, New York.

A NEW MOTOR-DRIVEN PUMP.

Fig. 1 herewith illustrates an extremely compact and effective combination of duplex pump and electric motor which is being marketed by Charles S. Pease, New York. The pump is of special design, for which Mr. M. W. Hall is responsible. The plungers are driven from two large crankpins on opposite ends of the pump shaft; mounted on the center of this shaft is a worm wheel which meshes with a worm on the end of the motor shaft. All of this gearing is enclosed in the lower casing of the pump structure and submerged in oil, so that no lubrication from the outside is required. The construction of the pump proper is very unusual, and one of the strong features of the combination; it is not practicable to describe this construction adequately without illustrations of the details, and these are unfortunately not available now on account of the patent status. These little pumping outfits are admirably adapted for supplying water tanks on office buildings, hotels, residences and apartment houses; they are said to be entirely noiseless, and since no external application of lubrication is necessary and the switch controlling the motor is of the usual automatic-float type, the motor and pump will run for months without any attention. Any of the standard motors are supplied, according to the preference of the purchaser.

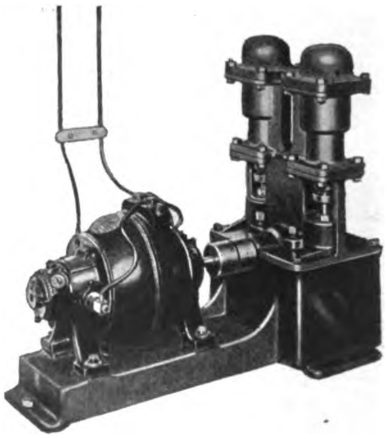

FIG. 1.—MOTOR-DRIVEN PUMP.

New Apparatus and Appliances

ELECTRICIAN'S TOOL CHESTS.

Fig. 1 herewith shows a steel tool chest for electricians manufactured by William Vanderman, of Willimantic, Conn. The chests are made of cold-rolled 3/16-in. sheet steel with malleable iron corner pieces and hard wood braces. They are fitted with heavy wrought iron hinges and hasp, and the cover is so arranged as to be held open by a support from the back of the chest. Each chest is furnished with a brass lock and two keys, and bolts to screw down the cover at the front corners. The chests are painted, well proportioned and ornamental in design. They are made in six styles and four sizes to each style.

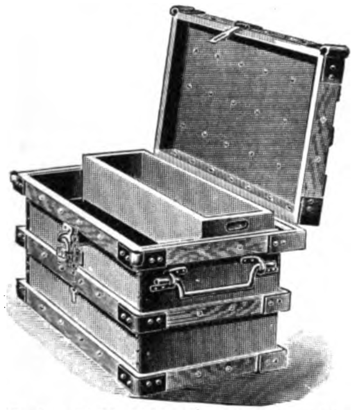

FIG. 1.—ELECTRICIAN'S TOOL CHEST.

A NEW TESTING SET.

Machado & Roller, the selling agents of the Whitney Electric Instrument Company, are marketing a new form of testing set, of which an illustration is presented herewith. It is of the decade pattern in which the drawbacks incident to the great number of plugs necessitated by the old Post Office form of construction are eliminated, there being but four plugs in the rheostat itself. It will be noticed that the use of reversing blocks in the bridge arms has been done away with by adding an extra coil to each arm. This expedient eliminates two plugs and makes the operation of the set more easy to understand. The keys are of a novel form which can be operated independently or like the conventional combination key, whichever is desired. Five large dry cells are built into the containing case and a flexible cord with plug is arranged so that any number of them can be used at will. An ingenious modification of the ordinary construction of decade and post office sets is used to shift the internal connections from those employed in making ordinary resistance measurements and the Murray test to the connections for the Varley test, so that the two "X" posts common to every bridge are the ones to which the outside line is always attached no matter what test is being made thereon. A pair of binding posts to which an external galvanometer of the reflecting form may be attached for very sensitive work is also provided and by shifting one plug, either this external galvanometer or the one that is built into the set is brought into play. Another pair of posts permits the use of an external source of electro-motive force where this is desired. Instead of following the conventional procedure of marking the ratio arm blocks "A" and "B," they are stamped "Divide by" and "Multiply by" respectively, the connections being such that, when a plug is inserted in the gap between the "divide by" block and any one of the four circular blocks opposite thereto, the readings as indicated by the position of the plugs in the rheostat are to be divided by the number stamped on the circular block to get the correct reading. Similarly, the resistance plugged in in the rheostat is to be multiplied by the number indicated by the position of the plug in the "multiply by" ratio arm block. The plug blocks for changing over the loop and galvanometer connections are marked with similar clearness so that practically anyone can use the bridge without chance of confusion. The actual diagram of connections is as shown by the line cut herewith. An accuracy of adjustment of a tenth of one per cent throughout is claimed, and it is also stated that the galvanometer is sufficiently sensitive to give a marked deflection with a tenth of a per cent resistance variation when working with full battery power on a resistance of moderate value. The galvanometer is not affected by external fields and can be used with the set in any position.

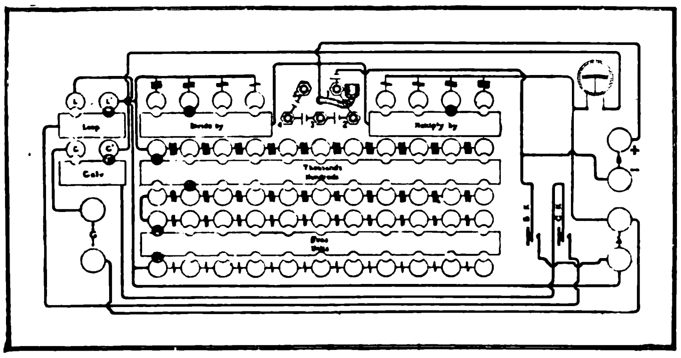

FIG. 2.—DIAGRAM OF CONNECTIONS.

ELECTRICALLY OPERATED WHISTLES.

Fig. 4 herewith shows a solenoid attachment brought out by the Electrical Appliance Company, of Cincinnati, Ohio, by means of which a steam or other kind of whistle may be operated from a distance by simply pushing a button, or by a clock which automatically makes the contacts at the desired times. The device is said to operate any whistle up to 3 ins. in diameter which is under a pressure of 150 pounds, or when provided with larger valve will operate a 6-in. whistle under the same pressure. Where the available current is alternating, a Churcher rectifier is supplied with the outfit.

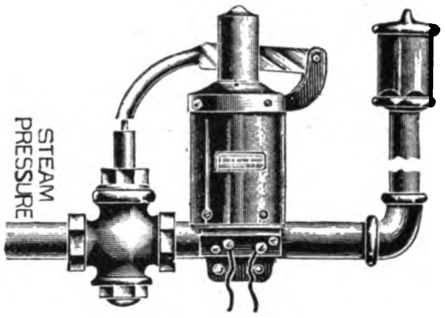

FIG. 4.—ELECTRICALLY OPERATED WHISTLE.

P-K ATTACHMENT PLUGS.

Figs. 5 and 6 show two of a line of P-K attachment plugs for 1904 which cover both the brass cap and porcelain types. The new "Pushin" type shown by Fig. 5 operates on an entirely new principle, as it is inserted and attached by simply pushing it into the socket, without any twisting of the cord. The two side springs, formed in ex-

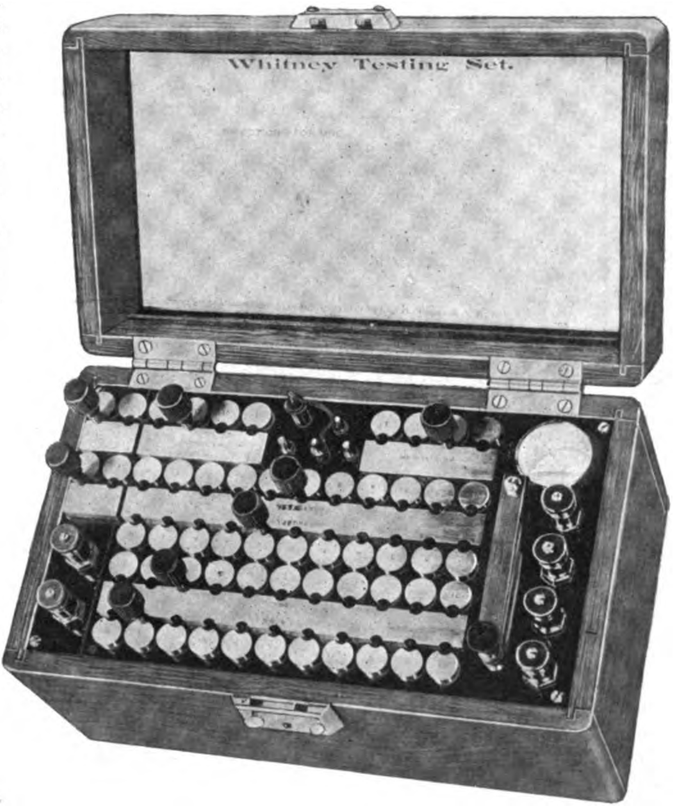

FIG. 3.—WHITNEY TESTING SET.

act shape to fit the Edison screw shell, securely hold the plug in place, while a third spring at the end completes the circuit. These springs are all of special phosphor-bronze. The No. 430, shown by Fig. 6, is the standard "P-K" attachment plug and is made for Edison, T-H and Westinghouse bases. The brass caps are fiber lined with fiber-bushing already in place in the cord opening. These caps are securely held by two side screws which enter recesses in the porcelain base. All styles of "P-K" attachment plugs have cord-openings at least 3/32" in diameter, so they are easily wired with reinforced show window cord. The plugs are made by the H. T. Paiste Company, of Philadelphia.

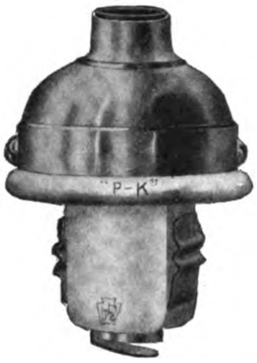

FIG. 5.—"PUSHIN" PLUG.

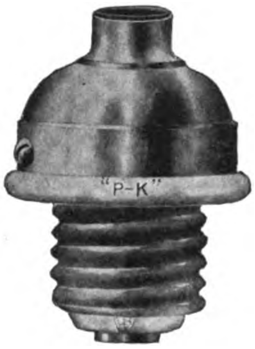

FIG. 6.—"P-K" ATTACHMENT PLUG.

ANDRAE O. K. DISTRIBUTION BOX.

Fig. 7 herewith shows a patented junction box brought out by the Julius Andrae & Sons Company, of Milwaukee, Wis., which is claimed to be at once a switchboard, testing board and junction box. The box is of cast metal and the front side has a removable cover with brass bolts and screw connections, and is provided with a rubber gasket to keep out the moisture. The bottom of the box has two or more tapped openings for screw threaded brass nipples, engaged by the cables, and these brass nipples and cables are united by soldering joints. Looking into the box is seen an insulating base of hard rubber, and by means of screws this insulating base is fastened to a ledge projecting from the sides and ends of the box. The insulating base is provided with brass contacts mounted on hard rubber ribs, to which wires leading from the cables are attached, being first put through small individual openings, bringing same to the front; each connection, therefore, is in plain view and work can be performed with rapidity. An insulating compound is poured into the rear of the box—back of the diaphragm, through an opening provided on top of the box, and when completely filled the opening is closed by a screw plug. Each box is provided with two goose necks, which can be attached whenever necessary under the front of the box, through which wires are brought out to the pole or elsewhere after which these goose necks are filled with an insulating compound. The device affords an easy and quick access to each conductor of a cable for connecting, disconnecting, cross-connecting and testing. It also allows the quick locating and cutting out of any defective portion of a system.

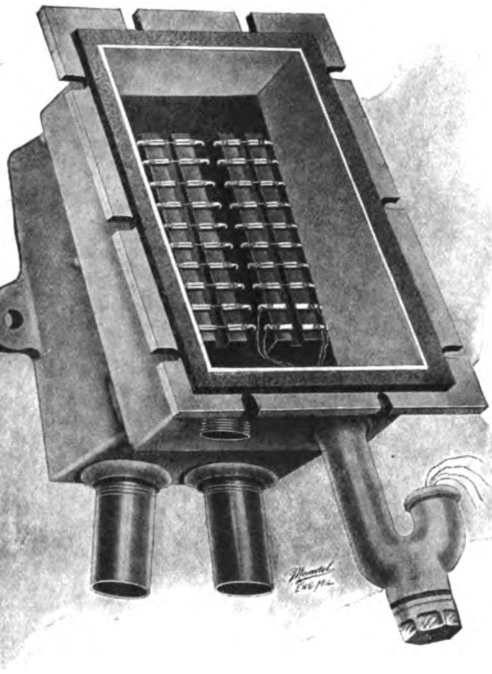

FIG. 7.—UNDERGROUND DISTRIBUTION BOX.

MOTOR-DRIVEN BUFFING LATHES AND DRY GRINDERS.

In order to supply the demand for effective electric motor-driven buffing lathes and dry grinders a line of these have been placed on the market by the Bridgeport Safety Emery Wheel Company and the Crocker-Wheeler Company. It is a complete line of motor-driven tools of this class of extremely neat and effective construction. Instead of extending an ordinary motor spindle and making a base to fit the motor, the emery wheel builder supplies shafts upon which the Crocker-Wheeler Company mount their armatures. The shaft is larger and stronger than necessary for an ordinary motor shaft and supported by unusually long bearings to secure rigidity against the vibration to which these tools are subject. The design of the motor is slightly modified to make the two a harmonious unit in every particular. Machines of this class must of course be fully inclosed, and the problem of cooling by air is a serious one. This has been solved by having the lower half of the motor open directly into the base casting. The air contained in the inside of the base is thus added to the quantity that circulates around the inside of the motor, and enables it to run much cooler than an ordinary fully inclosed motor of the same size and capacity. By this means of inclosure from five to eight times as much cooling air is said to be available as in ordinary fully inclosed motors of equal power, the base also giving an in-

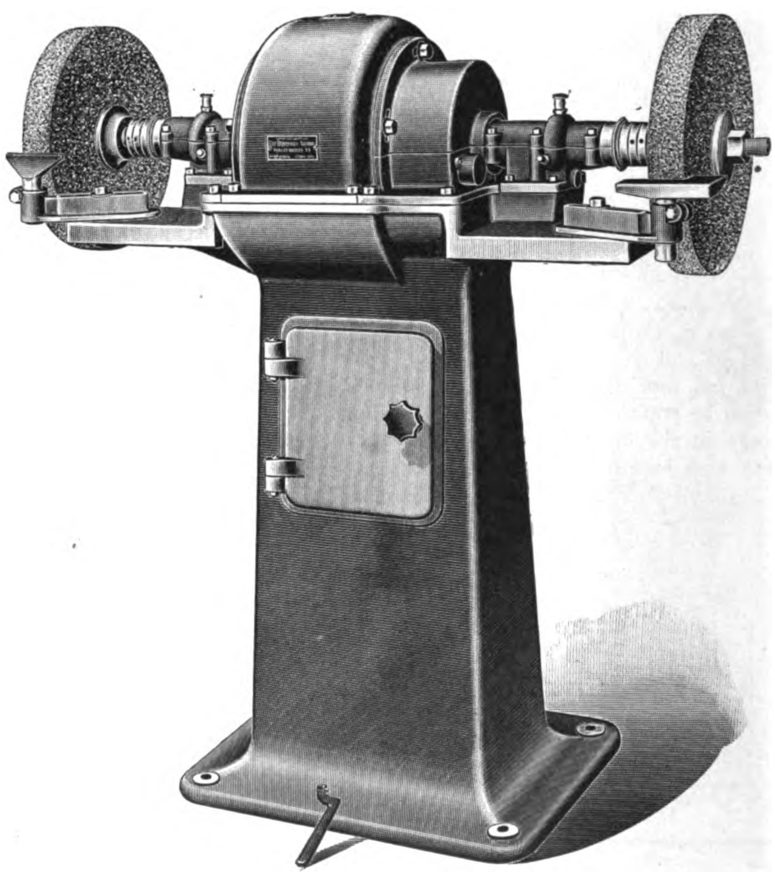

FIG. 8.—MOTOR-DRIVEN BUFFING LATHE AND DRY GRINDER.

creased surface from which to radiate the heat. The armature and brush mechanism is covered with an end shield, split horizontally. The lower half contains the brush holders and wire connections; the upper half is attached to the motor frame by cap screws. This upper half of the frame can thus be readily taken off, giving quick and easy access to the armature and brushes. The machines are equipped with ring oiling bearings. On the outer end of each box is a dust proof collar, held in place by a key with two ring nuts, to compensate for all end wear and thrust of the spindle. The machines are strong, rigid, compact and self-contained. All wires and connections being inside, a short circuit through outside terminals is impossible. The starting box and switch are inside the base and are easily reached by the operator through a door. The machines can be used with either underneath or overhead wiring as desired, and are complete with starting- box with no-voltage release, knife switch, and fuses ready to connect line wires.

TRUMBULL PORCELAIN BASE SWITCH.

Fig. 9 herewith shows a new porcelain base switch brought out by the Trumbull Electric Manufacturing Company, of Plainville, Conn. This is a modification of the type "B" switch made by the same company and has been designed with a view to making a cheaper switch, while at the same time not reducing the efficiency. The switch has been adapted to a porcelain base and, it is said. conforms to the underwriters' requirements. All of the metal parts are made of pure copper, with hard fibre cross bars. The switch has the same spring finger contact as the regular type "B" switch.

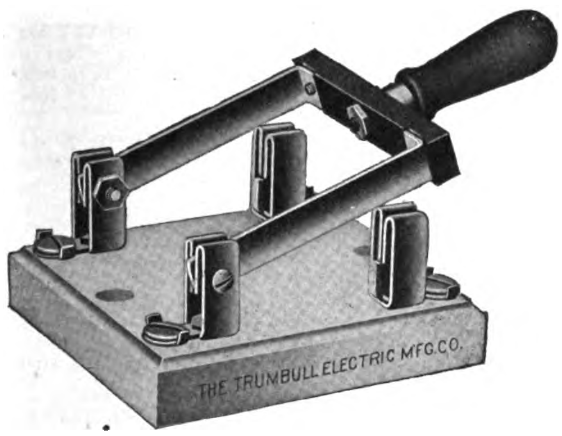

FIG. 9.—PORCELAIN BASE SWITCH.

STURTEVANT IMPROVED HAND BLOWERS.

The accompanying illustration shows a new design of hand blower brought out by the B. F. Sturtevant Company of Boston, Mass. This is known as type "B" and is an improved form of type "A" built by the same company. They are not only adapted to forge blowing but can readily be applied as portable ventilating apparatus. The running gear is simple, effective and strong. The blower is adjustable on the shaft, and its outlet may thus be set to discharge in any direction and is readily connected to the forge tuyere by means of galvanized iron piping. The blower is of cast iron. It has a steel shaft running in babbitted boxes and a fan wheel of galvanized steel solidly riveted to a composition hub with extending arms. The frame is arranged so that the slackness of the belt driving the blower may be taken up by lowering the blower shaft which is supported by collars sliding on the frame. The feet are provided with holes so that the blower may be screwed to the floor. These hand-blowers are made in two sizes. The total length on the floor of Style B-1 is 18 inches, while the total height of the frame, not including the handle, is 48 inches. The driving wheel is 24 inches in diameter, the blower outlet is 3½ inches in diameter and the complete outfit weighs but 135 lbs. Style B-2 is of slightly larger dimensions and has proportionately greater capacity for delivering air. The driving wheel is 24 inches in diameter, the blower outlet is 4¾ inches in diameter and the complete outfit weighs 155 lbs.

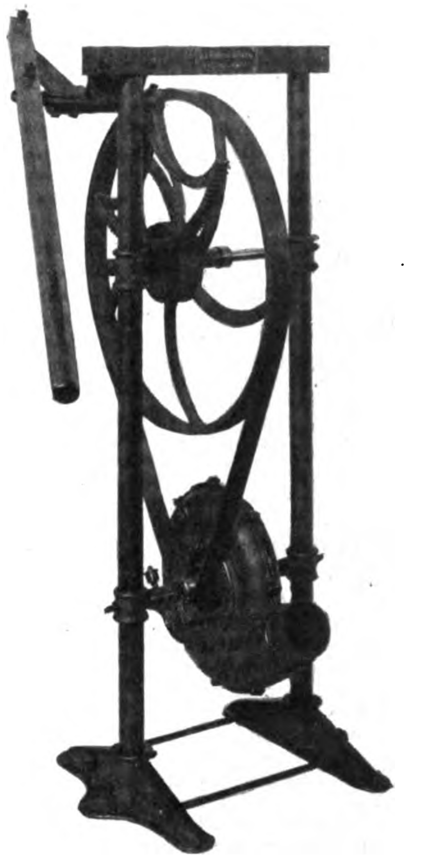

FIG. 10.—STURTEVANT HAND BLOWER.

NEW FORM OF FUSE.

A new fuse that has just been introduced by the Horton-Massnick Company, of Detroit, Mich., is illustrated by Fig. 11 herewith. The fuse is especially for set-screw contacts with centers which engineering practice has established. Both terminals are flexible and will take any centers from 1⅜ inche to 3 inches. The fusing material is formed in the shape of the letter U and is entirely surrounded by finely divided refractory material, with the exception of a very short portion, which is exposed to view through a hole in the bottom of a brass cap, which seals the open end of the fuse case or tube. The hole in the brass cap is covered by a transparent disc and the fuse is so constructed that the fusing material will blow exactly under this window. The user can determine at a glance whether or not the fuse is blown, because he can see the fusing material itself or the blackened window resulting from the blown fuse. The fuse is designed for 250-volt work and can be furnished in capacities from 1 to 30 amperes.

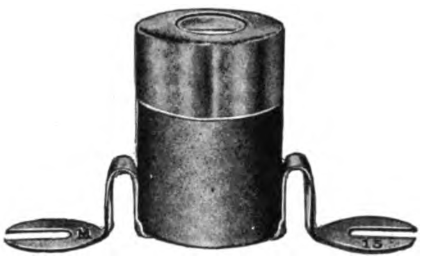

FIG. 11.—HORTON-MASSNICK FUSE.

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NEW BOOK.

DYNAMO ELECTRIC MACHINERY. (Seventh Edition.) By Prof. Silvanus P. Thompson. New York: Spon & Chamberlain. Buckram; 996 pages, 5½ ins. x 8½ ins.; 573 illustrations; numerous tables; 30 construction plates. Price, $7.50.

The present edition of Prof. Thompson's well-known text book contains a great deal of new material which includes most of the matter in his recently-issued "Design of Dynamos," and the old material has been very fully revised. The author has at last adopted the method of dealing with electromagnetic exciting force on the basis of ampere-turns per unit length of magnetic path, which was used by the reviewer twelve years ago, and has been in general use in this country for at least nine or ten years. The exposition of fundamental principles remains practically unchanged, of course, in the new edition, but the details of construction, methods of design and other features which change with progress in the art have been brought up to date. This is especially noticeable in the sections devoted to armature construction, commutators and brushes, losses and heating, analysis of dynamo design and examples of modern machines. Many of the author's empirical rules do not agree with American practice, and it is difficult to see how some of them can agree with actual practice anywhere; for example, his assumptions that the effective air-gap area is the mean of the pole-face area and the area of the tooth tops under the pole, and that the field ampere-turns required to drive the flux through the armature teeth can be based on the magnetic density in the top or widest part of a tooth (page 613). Unless the teeth are worked at densities far below any practice thus far published, the effective air-gap area must be considerably greater and the magnetomotive force demanded by the teeth will be very much higher than the author's rules would provide. However, in view of the splendid material contained in the book, these discrepancies are insignificant. An excellent chart showing the magnetic properties of sheet steel at very high densities and other materials at ordinary densities has been added, and will doubtless be of great convenience to European designers using the brands of iron and steel from which the curves were plotted. There are also new sections on special types of dynamos, motor-generators and boosters, and rheostats, controllers and motor starters. The material on alternating-current apparatus which was in the previous edition has been omitted altogether to make room for the new matter on direct-current machinery, and will, presumably, be revised and published in a separate volume, the present book being designated Volume I.

PERSONAL.

MR. S. P. SHEERIN, president of the Indianapolis Telephone Company, recently sailed for Europe with Mrs. Sheerin for a three months' rest.

MR. C. S. PLATT has been appointed Eastern representative of the Sterling Electric Company, of La Fayette, Ind., with headquarters at 346 Broadway, New York.

MR. IRVING A. TAYLOR, who has had a wide experience in central station and high-tension transmission work, has joined the staff of the Engineering Company of America.

MR. JOHN B. ALLAN has resigned his position of general sales manager for the Allis-Chalmers Company and expects to take a two-months' vacation before again engaging in active work.

MR. W. A. ROSENBAUM, the well-known patent attorney, has formed a copartnership with Mr. W. M. Stockbridge under the style of Rosenbaum & Stockbridge. The firm's headquarters are at Mr. Rosenbaum's old address, 140 Nassau Street, New York.

MR. J. T. P. KENYON has resigned from the New York Edison Company's engineering department to accept the position of chief draughtsman of the New York Central & Hudson River Railroad Company's electrical department.

MR. R. A. FLIESS, who has been associated with Mr. Edison for the past few years in the development of the new Edison storage cell, delivered a very interesting lecture before the New York Electrical Society on April 27.

MR. H. V. CROLL, who has for several years had charge of the Allis-Chalmers Company's Salt Lake City office, has been transferred to the management of the San Francisco office of that company, which is at 623 Haywood Building.

MR. FRED W. WALTER has established an office at Norfolk, Va., for the representation in that vicinity of several well-known manufacturers. Among those whom Mr. Walter will represent are the C. & C. Electric Company and the Stanley Electric Manufacturing Company.

LIEUT.-COMMANDER J. B. BLISH, who has for the past six months been inspecting the apparatus built for the U. S. Navy at the General Electric Works in Schenectady, has been compelled to abandon his work there temporarily on account of illness, and is now at the New York Naval Hospital under treatment.

MR. LYMAN C. REED has severed his connection with the Interstate Electric Company, New Orleans, and formed a partnership with Mr. William T. Spranley for the purpose of engaging in contract electrical engineering. The style of the firm is Spranley & Reed, and their headquarters are in the Hibernia Bank Building, New Orleans.

MR. GEORGE A. FULLER, retiring assistant electrical engineer of the Schenectady Railway Company, was given a banquet recently at the Hotel Ten Eyck, Albany, by the railway company's staff. The general manager, Mr. E. F. Peck, officiated as toast master, and Superintendent Frederick Smith presented Mr. Fuller with a set of solid silver back brushes.

MR. PUTNAM A. BATES, who recently resigned the sales management of the Crocker-Wheeler Company, and Mr. John Neilson have formed a copartnership for the practice of consulting electrical engineering. The style of the firm is Bates & Neilson, and its headquarters are at 42 Broadway, New York. Both members of the firm are splendidly qualified by long experience for the class of work they have undertaken.

MR. J. H. HALLBERG, the well-known authority on electric arc lighting, who was for several years in charge of that department of the General Incandescent Arc Lighting Company's business, and recently added to his fame by reorganizing the arc lighting system of the Cincinnati Gas & Electric Company, has decided to engage in consulting engineering on his own account. Mr. Hallberg will devote his attention to electrical distribution and illumination and has established headquarters at 45 Broadway, New York.

TRADE PUBLICATIONS.

WIRE ROPE AND FITTINGS. American Steel & Wire Company, Chicago and New York.—This is the 1904 edition of the company's catalogue of wire ropes, sheaves, clamps, end sockets, thimbles, and other appliances used in connection with such rope.

WOOD ALTERNATOR INSTRUCTION BOOK. Ft. Wayne Electric Works, Ft. Wayne, Ind.—This is instruction book No. 3019 and contains a complete description of the well-known Wood alternators, with full instructions for operating and general handling.

DISC VENTILATING FANS. American Blower Company, Detroit, Mich.—Catalogue No. 161, devoted to the well-known A.B.C. disc fans which were fully described in the March number of this paper. These fans are built, of course, for any of the standard methods of driving.

SINGLE-PHASE INDUCTION WATTMETERS. Ft. Wayne Electric Works, Ft. Wayne, Ind.—This is Bulletin No. 1053, superseding Bulletin No. 1017 and describing the Ft. Wayne "Type K" integrating watt-hour-meter for single-phase alternating-current circuits.

MAGNETO CIRCUIT CLOSER. The Holtzer-Cabot Electric Company, Boston.—Bulletin No. 206, describing a sensitive relay which is operated by magneto current and arranged to close another circuit when so operated. The main circuit remains closed until the apparatus is reset.

DIRECT-CURRENT GENERATORS AND MOTORS. National Electric Company, Milwaukee, Wis.—This is catalogue No. 61 and contains profusely illustrated descriptions of the extensive line of direct-current machinery built by this company. The catalogue is executed in the handsome style characteristic of the company's publications.

MAGNETO RECORDING CLOCKS. The Holtzer-Cabot Electric Company, Boston, Mass.—Bulletin No. 152, containing an illustrated description of the Holtzer magneto clocks for recording watchmen's signals. These clocks are made to record signals from any number of stations up to 25, and, when desired, are provided with two or three recording dials.

SWITCHBOARDS. The F. Bissell Company, Toledo, Ohio.—A very complete pocket size pamphlet containing a list of complete switchboards for different classes of service. The dimensions of each type of switchboard are shown by an outline drawing, and a detailed list of the apparatus with which the board is equipped is printed alongside the drawing.

ELECTRICAL AND STEAM MACHINERY. Rossiter, MacGovern & Co., Inc., New York.—A very compact list of second-hand apparatus for sale on May 1. All of the apparatus sold by this company is thoroughly overhauled at one of its factories and put in first-class operating condition before it is offered for sale. The present list includes almost every class of electrical and allied machinery.

BUSINESS NEWS.

THE WHEELER CONDENSER & ENGINE COMPANY has moved its New York offices to 42 Broadway.

AUBURN BALL BEARING COMPANY has removed its main office and works from Auburn to 18 Commercial Street, Rochester, N. Y.

STANLEY & PATTERSON, Inc., New York, have removed their general offices and salesrooms from 93 Liberty Street to 40 Cortlandt Street.

THE GENERAL ELECTRIC COMPANY, it is reported, has secured the rights to manufacture under the Reidler-Stumpf turbine patents in this country.

THE FAHNESTOCK TRANSMITTER COMPANY has removed its headquarters to 132 Havemeyer Street, Brooklyn, near the entrance of the new Williamsburg Bridge.

JOS. H. THOMPSON, JR., has established offices at No. 11 Broadway, New York, for buying, selling and exchanging electrical and steam machinery and appliances of every description.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, recently received an order from the Russian Government for six Cross oil filters, which is the tenth order that has been received from Russia.

THE SHEPHERD ENGINEERING COMPANY, Franklin, Pa., has located its Boston branch office in the new Oliver Building, at the corner of Oliver and Milk Streets, in charge of Mr. W. N. Clifford.

WESTERN ELECTRIC COMPANY'S NEW PLANT.—Contracts for additional buildings in connection with the Western Electric Company's plant at Hawthorne, Ill., have been let. These, it is estimated, will cost about $100,000.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, has a very comprehensive display of its line of steam specialties in Machinery Hall at the Louisiana Exposition. The exhibit is No. 5-G in block 26.

THE JONES FAN & MOTOR COMPANY has been incorporated in New York with a capital stock of $2500. The directors are C. D. Marsh, L. A. Landau and James Jones, Jr., all of New York.

ALLIS-CHALMERS-BULLOCK, LTD., is the style of the Canadian organization of the Allis-Chalmers and Bullock Electric Manufacturing Companies of this country. The works and principal offices of the Canadian company are in Montreal.

THE AMERICAN PUSH-BUTTON TELEPHONE COMPANY, New York, announces that it has been authorized by the court to change its legal name to Anders Push-Button Telephone Company, the authorization taking effect on and after May 7, 1904.

THE TALMONT ELECTRIC ENGINEERING COMPANY has been incorporated in New York with a capital stock of $5000. The officers are Adolph Talmont, president; G. D. Roedelsberger, vice-president, and M. J. Hornthal, secretary and treasurer.

A CORRECTION.—In this department of last month's issue it was stated that Mr. George L. Crosby had been appointed district representative for the Western Electrical Instrument Company at Cleveland. This should have read Weston Electrical Instrument Company.

THE WILLIAM TOD COMPANY, of Youngstown, Ohio, has established a branch office at 29 Broadway, New York, under the management of Mr. Geo. F. Woolston, formerly of the well-known firm of Woolston & Brew. The Tod Company is building full lines of Corliss heavy duty engines, pumping engines, blowing engines and gas engines.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has issued a cordial invitation to the electrical fraternity at large to visit and use its offices as headquarters during the World's Fair period. The company will provide stenographic facilities and other conveniences for visiting friends.

HOLMES METALLIC PACKING COMPANY, Wilkesbarre, Pa., reports that its fiscal year just closing has been very prosperous and that its orders are increasing daily under the able management of Geo. D. Rollins. The company contemplates increasing its facilities for turning out some of its most popular metallic packings.

JOSEPH E. LOCKWOOD, Detroit, Mich., has been appointed Michigan sales agent for the Bullock Electric Manufacturing Company. Mr. Lockwood is one of the pioneer electrical supply men of the country, and is well known throughout the electrical field all over the United States. Mr. Lockwood will also act as representative for several other interests.

JAMES S. BARRON & CO., New York, state that in spite of the fire which recently destroyed their building and all the contents, amounting to $185,000, they have taken new quarters at 339 Greenwich Street, where they will remain until the completion of their new building on the old site, which will be about May, 1905. The damage was fully covered by insurance.

MOLONEY ELECTRIC COMPANY, St. Louis, Mo., is an excellent example of the value of specilization. Having decided on the exclusive manufacture of alternating-current transformers, the company has devoted its entire energies and talent to that subject, and the result has been a remarkable growth in its business. The company has just moved into a new factory having an aggregate floor space of over 35,000 square feet devoted entirely to the manufacture of transformers.

THE AUTOMATIC ELECTRIC COMPANY, of Chicago, is now installing 4,000 automatic telephones and complete switching equipment for the Home Telephone Company, of Los Angeles, Cal., and 1,200 instruments for the Auburn Telephone Company, Auburn, N. Y. The company has also received orders for an exchange equipment for San Diego, Cal., of 1,200 automatic telephones and one at Lewiston, Me., of 1.500.

EWING-MERKLE COMPANY, St. Louis, Mo., has issued a very convenient map of the World's Fair Grounds. The map is 8x12 inches in size and folds into a neat envelope which can be carried in the vest pocket. It shows the location of all the buildings and features of the Exposition and is provided with an index which enables one to find any building or feature without delay. Copies are sent free on application.

THE DERRY-COLLARD COMPANY, New York, is making very convenient sketching pads for isometric perspective drawings. The pads are ruled like cross-section paper, and have in addition diagonal lines ruled at an angle of about 30 degrees with the horizontal. The pads have 50 sheets each and are made in two sizes, 6x9 ins. and 9x12 ins. The paper is also supplied in loose sheets 12x18 ins.

THE S. H. COUCH COMPANY, Boston, Mass., recently closed several important contracts for telephone equipment, among which may be mentioned the La Fayette Hotel, Portland, Me., where 140 instrumetns will be installed in connection with a common-battery switchboard of the company's new target type. Common-battery instruments have also been sold to the Worcester (Mass.) City Hospital and the Hartford Carpet Corporation, Thompsonville, Conn.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., are represented at the Louisiana Exposition by a handsome building facing the Plaza in the Model Village. The lower floor of the building contains an exhibit of the plans and methods of the schools, with specimens of the work done by students, while the upper floor contains a reading room, writing room and post office for the use of students of the schools and their friends.

THE WATSON-STILLMAN COMPANY has removed its offices and stock of goods to 46 Dey Street, New York City, and all machinery to the new works at Aldene, Union County, N. J., where the company will have ample room to expand. The works are located at the junction of the Lehigh Valley Railroad, the Baltimore & Ohio Railroad, and on the low-grade connection between the Lehigh Valley Railroad and the Central Railroad of New Jersey, with a track 1,000 feet long in the company's yard.

THE NERNST LAMP COMPANY has established a branch office at 537 Schofield Building, Cleveland, Ohio, in charge of Mr. J. C. Wright. The Cleveland office will carry a full stock of Nernst lamps and renewal parts. The company reports a rapidly growing business in the New England district. Large orders were received recently from the Saco & Pettee Machine Shops, Biddeford, Me., for three-glower lamps, and from the Arlington Mills, Lawrence, Mass., for 600 lamps of the 44-watt type. The latter is the second lot of Nernst lamps ordered by the Arlington Mills.

CHAPMAN VALVE MANUFACTURING COMPANY, Indian Orchard, Mass., suggests that those who attend the convention of the National Electric Light Association at Boston, Mass., will undoubtedly find a visit to the K Street Station of the Edison Electric Illuminating Company very interesting. Here the pipe lines feeding superheated steam to the steam turbines are fitted with Chapman valves designed especially for that service. In the same station may also be seen Chapman valves equipped with electric motors for quick, easy and certain operation. Both of these ideas are a new departure in power-house equipment and represent the very latest improvements in modern practice.

ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, has a very extensive exhibit at the St. Louis Exposition in block 20, Electricity Building. A conspicuous feature of the exhibit is a map, 30 feet high and 45 feet wide, on which is shown the distribution of Chloride accumulator installations throughout the United States. The character of each installation is indicated by an illuminated glass lens. Specimens of Chloride accumulators, ranging from the smallest laboratory cells up to the 61-H type, are shown, and a complete exhibit of the Exide automobile battery is also shown. In another section of the exhibit there are shown five types of switchboards with end cell switches, storage battery recording instruments, etc., and there is a complete operating installation of Chloride accumulators for railway service in a model battery house.

WHITNEY ELECTRICAL INSTRUMENT COMPANY (Machado & Roller, general agents) announce that Judge Lacombe, of the United States Circuit Court for the Southern District of New York, on May 9 denied the application of the Weston Electrical Instrument Company for a preliminary injunction against the Whitney Company and Machado & Roller in the suit for infringement of Weston patent No. 392,387, which was recently sustained against other instrument manufacturers. The case was argued at length by Messrs. Kenyon & Kenyon on behalf of the Weston Company and by Mr. C. V. Edwards on behalf of the Whitney Company. Machado & Roller, the general selling agents of the Whitney Electrical Instrument Company, announce that, in addition to this decision, another suit brought by the Weston Company against the Whitney Electrical Instrument Company and themselves on Weston patent No. 446,489 was dismissed upon final hearing by the Court in October last. The defendants are naturally elated over these decisions.

THE STANLEY UNDERGROUND CABLE COMPANY, Pittsburg, and the **McROY CLAY WORKS,** Brazil, Ind., have an interesting joint exhibit at the St. Louis Exposition in section 3 of Electricity Building, which is near the northwest entrance of that building. The exhibit shows a cross-section of a conduit having 72 ducts with a man-hole at each end, one man-hole being complete with a cover and the other open. A trench extends the full length of the conduit, allowing inspection of the method of laying, the general construction of the man-holes, etc. In one man-hole a capstan is rigged up for drawing in cables, and a rope extends from the capstan to the end of a cable in the conduit, the cable being drawn through the conduit from a reel in the other man-hole. Cables extend from the man-holes to distributing poles, showing the methods of distribution for different classes of electrical work. The Standard Underground Cable Company shows also samples of its extensive line of cables and appliances enclosed in handsome cases, and the McRoy Clay Works exhibits individually piles of clay as it comes from the ground and the various processes to which it is subjected.

CENTRAL STATION NEWS

ALABAMA.

BIRMINGHAM.—Extensive improvements are now under way at the plant of the Birmingham Railway, Light & Power Company; these include the installation of new boilers and a new 1500-kw. alternator. The sub-station, at Brighton, has been completed and machinery installed for converting high-tension alternating current to low-voltage direct current. This plant will supply current for lighting purposes in Brighton and also furnish power for two car lines running to Bessemer, thus saving the loss which now occurs by reason of the long circuit and low voltage of the supply. It is also stated that in the near future provision will be made to supply Bessemer with current from the same source, or from a converting station located in that city.

ARIZONA.

MORENCI.—The Arizona Copper Company is interested in the construction of an electric plant on Blue River to furnish light and power for the mining camp and town.

TEMPE.—The Tempe Pumping Company has been organized to pump approximately 450,000 gallons of water per minute for irrigation purposes; the plan being to pump 11,250 gallons of water per minute in the power plant and to transmit electric power to five sub-stations for pumping the remainder. Electricity will also be generated for industrial and lighting purposes. The power plant, which is to be a steam plant exclusively, is now in course of construction and will probably be in operation by July 15.

ARKANSAS.

LITTLE ROCK.—In his annual message, the Mayor recommended installing 40 more electric lights and a new boiler room for the electric light plant; he also said that all wires should be placed underground.

CLARKSVILLE.—Mr. E. T. McConnell has been granted a thirty-year franchise for an electric light plant to be completed in six months. It is understood that Mr. McConnell will begin the erection of the plant immediately.

CALIFORNIA.

SAN DIEGO.—The San Diego Gas & Electric Light Company is planning to extend its pole line to National City.

LODI.—The Lodi Electric Works have been absorbed by the Northern San Joaquin Electric Company.

LOS ANGELES.—The San Gabriel Electric Company has leased the plant of the Sierra Power Company.

ALTURAS.—The Alturas Electric Light & Power Company, with a capital stock of $20,000, has been incorporated by D. E. Mulkey and I. W. Gibbons.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

LEMOORE.—It is expected that a 75-h.p. engine and a 50-kw. alternating-current dynamo will be added shortly to the equipment of the municipal electric light and water works.

SAN FRANCISCO.—The Pacific Power Company is offering for sale the machinery of its electric power plant at 23 Stevenson Street, including two engines, four boilers, three generators and auxiliaries.

RED BLUFF.—It is understood that the Northern California Power Company will install at the gas works in this city a large electric plant to generate electric current for use in cases of emergency.

LOS ANGELES.—The Los Angeles Gas & Electric Company was recently incorporated by W. B. Cline, William M. Van Dyke, William Baurthyte and others. The company is capitalized at $5,000,000.

SAN FRANCISCO.—At the annual meeting of the Board of Directors of the San Francisco Gas & Electric Company, the article of incorporation were amended to increase the number of its members from 11 to thirteen.

OAKLAND.—A movement is on foot to have the electric wires on Telegraph Avenue placed under ground, and it is probable that the work will be undertaken by the electric companies in the near future.

CLOVERDALE.—The Riverside Water Company will, within a short time, install an electric motor and utilize electricity from the Cloverdale Light & Power Company's plant for the purpose of pumping water.

QUINCY.—Mr. J. D. Goodwin recently incorporated the Quincy Water & Power Company with a capital stock of $50,000. It is the intention of the company to improve the water works and to install an electric power plant.

MENDOCINO.—The Mendocino Electric Light & Power Company is now in full possession of the old Mendocino Lighting Company's plant. Mr. J. Grindle is president of the company and Mr. Albert Brown, secretary.

WATSONVILLE.—Press reports state that the Big Creek Power Company, of Santa Cruz, will purchase property in this city as a site for a plant to furnish the local circuit with electric power; about $100,000 will be spent in improving the service here.

CHICO.—The Valley Counties Power Company contemplates doing considerable work on its Nimshew plant the coming summer, and probably another line will be run to this city to be used, especially for the purpose of conveying power in case of emergencies.

OAKLAND.—Lightning recently struck one of the wires of the Standard Electric Company, with the result that the interior of the company's substation at Elmhurst was demolished, involving a loss of about $3000. Mr. W. H. Pollard is superintendent of the station.

MADERA.—Mr. F. A. Krogh, president of the Madera electric light works, is making arrangements for a new brick building as an addition to the present plant, which will be used to furnish power for a cold storage and ice plant to be erected in the fall. The new equipment will include a boiler and engine. The lines will be extended to parts of the town not heretofore lighted.

ALAMEDA.—The demand for electric power for day use is rapidly increasing here, and the Electric Light Committee of the City Trustees is inspecting the local plant with a view to installing day power for local consumption. Whether this will be generated at the municipal works or purchased from an outside company and distributed by the city is yet to be decided.

BAKERSFIELD.—The Power, Transit & Light Company, with a paid in capital stock of $2,500,000, is a consolidation of the Power Development Company, Bakersfield Gas & Electric Light Company, and the Bakersfield & Kern Electric Railway Company. Lighting current is supplied to both Bakersfield and Kern, and the company's equipment includes turbines with a total capacity of 2175 horse-power.

SACRAMENTO.—The American River Electric Company has secured permission from property owners between Folsom and Sacramento to erect an electric transmission line across their lands. The line is owned by A. Flieshhacker & Co., of San Francisco. The company has also secured a franchise to run its lines through Sacramento County and will shortly apply for the necessary privileges in Sacramento City.

LOS ANGELES.—The California Gas & Electric Corporation has cut up its great system into divisions; this section will be known as the Nevada County Division. A number of changes have resulted, which have been given out officially as follows: Mr. John Calvert, of Grass Valley, is manager of the distribution of power at the Grass Valley sub-station, and Mr. A. Rickard is manager of the hydraulic department; the Nevada City power house is under the management of Mr. Frank Nelson, and the commercial department is in charge of Mr. John Werry.

SAN FRANCISCO.—The Northern California Power Company is a consolidation of the Keswick Electric Power Company, Redding Electric Light & Power Company, Redding Water Company, Redding Gas Company, Red Bluff Gas Company, Tehama Electric Company, and Bellevue Irrigation Company. The company's capital stock is $2,000,000, and the following are its officers: President, Mr. H. H. Noble; vice-president, Mr. James Coffin; secretary, Mr. E. Whaley; manager, Mr. E. V. D. Johnson. Current is supplied to 108 arc lamps and 12,000 incandescent lights.

COLORADO.

SILVERTON.—The Town of Silverton is building about two miles of new line and 25 series arc lamps are to be installed for street lighting.

GRAND JUNCTION.—The Grand Junction Electric & Gas Company reports that it has doubled the capacity of its plant during the last three months.

GLENWOOD SPRINGS.—The Colorado Power & Irrigation Company, of Denver, has purchased a water right about twelve miles from this place on Grand River.

SALIDA.—The Chaffee County Electric Light, Power & Railway Company was recently incorporated with a capital stock of $500,000, the purpose of the company being to furnish electricity for light and power purposes and to construct a street railway line in Salida and its suburbs. The company will also construct lines to the towns of Buena Vista, Turret and Poncha Springs. Mr. T. E. Mason, of Des Moines, Iowa, is one of the directors.

CONNECTICUT.

SOUTH NORWALK.—The municipal plant of this city is extending its outside lines.

NORFOLK.—The installation of a new electric light plant is being considered by the town council.

BRIDGEPORT.—The large generator recently installed at the power house of the Connecticut Railway & Lighting Company stood the test to which it was subjected and is now ready for operation with the other equipment of the power station.

WOODBURY.—The Woodbury & Southern Electric Railway Company is being organized at this place, with a capital stock of $15,000 fully paid in. The company will furnish electricity for lighting both Woodbury and Southbury. The officers are: Mr. James Huntington, president; Mr. F. F. Hitchcock, vice-president; Mr. E. S. Boyd, secretary and manager.

MERIDEN.—The transformer plant which the Meriden Electric Railway Company has been erecting at Hanover Park has been completed and is now in operation. Under the new arrangement the power to operate the local trolley system will be transmitted from the power station at Berlin, a distance of nine miles. The new system will double the power available for the trolley service. The old power plant, it is said, will be kept in readiness for use in cases of emergency.

DANIELSON.—The People's Electric Light & Power Company, of which Mr. E. J. Walcott is superintendent, is making important additions to its plant. Two new dynamos capable of supplying 3000 lights each will be installed, also another boiler, and a new stack 100 feet high will be erected. This will more than double the present capacity of this plant. The company is also engaged in extending its line to Moosup, whence it will be continued to Central Village and Wauregan.

DISTRICT OF COLUMBIA.

WASHINGTON.—The Potomac Electric Power Company will, in the course of the coming summer, place under ground its 73,820 feet of overhead wires.

WASHINGTON.—Messrs. Edward S. Duvall, Jr., Warren Cochran and William T. Duvall are the incorporators of the Sitka Water & Light Company which recently filed articles of incorporation here. The capital stock is $20,000.

FLORIDA.

PALATKA.—The council has under consideration a proposition made by Mr. G. L. Bailey, offering to sell the gas works and electric lighting plant to the city for $60,000, he to take $30,000 worth of 5 per cent bonds at par as part payment.

GAINESVILLE.—The Gainesville Gas & Electric Light Company, which began operation early this year, has secured the city contract for supplying current to 14 arc lamps of 1200 candle-power and 45 incandescent lamps of 32 candle-power. Mr. George I. Doig is superintendent of the plant.

JACKSONVILLE.—It has been decided to install a new 500-kw. turbine-generator set in the city electric light plant, in order to meet the increased demand for lights. The turbine will be worked condensing at 150 lbs. steam pressure, and the generator of the set is to be a three-phase 60-cycle 2300-volt machine.

WEST PALM BEACH.—The East Coast Electric Light, Power & Ice Company was recently organized with a capital stock of $100,000, all paid up. Mr. Joseph Jefferson, Buzzard's Bay, Mass., is president; Mr. G. G. Strohm, vice-president; Mr. A. R. Beaujin, secretary, manager and superintendent. The company is supplying only lighting current at present.

GEORGIA.

THOMASVILLE.—The town authorities are considering the construction of water works and an electric light plant.

BLAKELY.—The water and electric light plant owned and operated by the city is reported to have been destroyed by fire April 15.

BLUE RIDGE.—The Blue Ridge Electric Light & Power Company, which began operations last year, expects to enlarge its plant in the near future.

THOMSON.—At a mass meeting held recently a system of water works and an electric light plant were agreed upon. The cost of constructing the works and plant is estimated at $25,000.

MILLEDGEVILLE.—The present officers of the Milledgeville Electric Light Company are reported to be as follows: President, Mr. Samuel Evans; secretary and treasurer, Mr. Lewis Andrews; manager and superintendent, Mr. Charles F. Hour; chief engineer and electrician, Mr. J. W. Marchman.

IDAHO.

BOISE.—The Inter-State Electric Company is arranging to construct a tunnel and a power plant on Snake River. The proposed plant will have a capacity of 50,000 horse-power.

POST FALLS.—The Washington Water Power Company is about to install a large power plant of from 8000 to 10,000 horse-power at this point. The plant will furnish power to Post Falls, and also to the Cœur d'Alene electric road.

SAND POINT.—The Sand Point Electric Company expects to install this fall a series alternating-current arc light system to take the place of the present multiple system. A 150 horse-power engine will also be added to the equipment.

ILLINOIS.

BLOOMINGTON.—The Union Gas & Electric Company states that it is not now operating its central station.

BERWYN.—The village of Berwyn contemplates extending the service of its electric light plant to include residence lighting.

TABLE GROVE.—A $4000 bond issue was recently voted for by the citizens, to take over the electric light plant or to install a new one.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

NEVADA.—The contract for the extension of its power station has been let by The Nevada Electric Company, also for the new electrical apparatus to be installed therein.

SAINT ANNE.—The plant of the Saint Anne Light & Water Company is now being operated by Trowbridge, Niver & Co., of Chicago, Ill. Mr. F. A. Flint is superintendent.

BATAVIA.—It is proposed to install a new air compressor at the power house of the municipal plant, and bids for furnishing the same will be received May 21.

GIRARD.—A larger alternating-current generator is needed in the plant of the Girard Electric Light Company, and it is expected that such a machine will be installed before very long.

MARSEILLES.—The property of the Marseilles Water & Light Company has been purchased by Mr. W. D. Boyce, who also owns the Marseilles Land & Water Power Company and now controls all the light and water franchises in the town.

CHICAGO.—Bids are wanted May 3 for furnishing the city with 50,000 feet of No. 6 rubber-covered lead-incased electric light cable and 6000 feet of 7-conductor (No. 16 B. & S. gauge) rubber-covered lead-incased fire alarm cable.

CARTHAGE.—The capital stock of the Carthage Electric Light & Power Company has been increased from $20,000 to $50,000, and the name of the company changed to Carthage Electric Light & Heating Company.

ELGIN.—Recent reports state that the Aurora, Elgin & Chicago Power Company has been purchased from the Aurora, Elgin & Chicago Railway by The Fox River, Light, Heat & Power Company, of this city.

PANA.—Mr. Robert Johns, successor to the Pana Modern Electric Light, Power & Street Railway Company, has also acquired the plant of the Consumers' Electric Light Company and consolidated the two companies. Mr. A. M. Read is superintendent and chief electrician.

MT. STERLING.—The Mt. Sterling Electric Light & Power Company has been making improvements at its power house, preparatory to installing a new 150 horse-power engine. The power house has been enlarged and it is estimated that the total cost of the improvements now under way will be about $3000.

FREEPORT.—Articles of incorporation have been filed by The Pecatonica River Power Company with a capital of $5000. It is the purpose of the company to operate electric lighting, railway and power plants. The incorporators are: Henry B. Witte, Joseph H. Vincent and Charles B. Courtney.

QUINCY.—The Quincy Gas & Electric Company, which is a consolidation of the Quincy Gas Light & Coke Company, the Empire Light & Power Company and the Thomson-Houston Electric Light & Power Company, has also absorbed the Quincy Steam Heat & Electric Company. Mr. George M. Massen is chief engineer for the company.

HOOPESTON.—The Hoopeston Electric Light & Heating Company is supplying current for operating the new electric pumping system which has been installed at the Hoopeston Water Works. There have been erected at the pumping station a compressor pump with a capacity of 300 gallons per minute, which will be driven by a 40 horse-power electric motor, and a triplex pump with a capacity of 25,000 gallons per hour, to be driven by a 30 horse-power motor.

INDIANA.

MADISON.—Mr. B. Spratt has been appointed chief engineer for the Madison Light & Railway Company.

WINAMAC.—Mr. G. F. Agnew is now general manager and superintendent of the municipal light and water plant.

NEW HAVEN.—The City Council has decided to construct an electric light plant, and bids for the same are wanted May 24.

MUNCIE.—The Muncie Light Department is rebuilding its plant, which will be housed in a new building and equipped with new machinery.

MARION.—The contract for the additional machinery to be installed in the city electric plant has been let to the Westinghouse Company.

PERU.—The Indiana Hydraulic Company, of which Mr. Jerome Herff is president, has about completed its plans for the construction of a dam, an electric power plant and an electric railway to run between Vincennes and West Baden.

MISHAWAKA.—The Mishawaka Woolen Mills recently installed another electric motor of 200 horse-power. The factory is now using 950 horse-power generated by electricity from the Hen Island power station, which is also supplying the company with electricity for lighting purposes.

SOUTH BEND.—The South Bend Electric Company has in course of construction a sub-station in South Bend, from which will be distributed the power obtained from the Irvin Branch dam of the St. Joseph & Elkhart Power Company and the Buchanan dam of C. A. Chapin.

TERRE HAUTE.—The new power house which is being erected here by the Terre Haute Electric Company is to be completed by next fall. It is understood that orders have been placed for all the machinery and the boilers are now ready for shipment.

NOBLESVILLE.—In regard to the city lighting contract for a period of ten years, it is reported that the bids received on April 18 were only two in number and were not opened. Bids will again be received on June 15 for lighting the city for ten years.

KOKOMO.—The Kokomo, Marion & Western Traction Company has in course of construction a new power plant to cost $150,000. It will be equipped with direct-connected units and is expected to be ready for operation by July 1. The company is also building an electric railway line from Kokomo to Marion, of which ten miles is now in operation, the balance to be completed by August 1.

VINCENNES.—The Vincennes Electric Light & Power Company, which was consolidated with the Citizens' Gas Light Company, is now controlled by E. M. Deane & Co., Grand Rapids, Mich. The officers are as follows: President, Mr. E. M. Deane, Grand Rapids; vice-president, Mr. Charles Bierhaus, Vincennes; secretary, Mr. F. S. Deane, Grand Rapids; treasurer, Mr. D. Smith, Grand Rapids; manager, Mr. H. B. Wales, Grand Rapids; superintendent, Mr. A. W. Frund, Vincennes; chief engineer, Mr. John J. McClure.

IOWA.

LOGAN.—The Logan Electric Light Company is adding a new boiler to its plant equipment.

BURLINGTON.—A special election is to be held to vote for a bond issue of $27,000 for the construction of an electric lighting plant.

MARION.—The Marion Light, Heat & Power Company is installing new generators at its plant, and is also adding a number of new street lights.

LEON.—The municipal electric light plant at this point will be sold by the city. Mr. I. N. Beard is chairman of the committee to effect the sale.

SPIRIT LAKE.—Mr. J. B. Thompson is superintendent and chief electrician of the municipal light and power plant, and Mr. W. H. Alton is chief engineer.

KEOKUK.—A bill has been prepared and presented to Congress, granting to the Keokuk & Hamilton Water Power Company the right to construct and maintain for the improvement of navigation and development of water power a dam across the Mississippi River; also to construct and maintain power stations for the generation, use and transmission of electric energy and power.

MOULTON.—The Moulton Electric Light Company was recently consolidated with the La Plata (Mo.) Electric Light Company under the style of the former company. The paid in capital stock is $12,000. The following are the officers: President, Mr. James Bolton, Moulton; secretary, Mr. R. W. Bolton, Alexis, Ill.; treasurer, Mr. George Bolton, Moulton; chief electrician, Mr. Sidney Boulton, La Plata. The company has the city lighting contract for both Moulton and La Plata.

KANSAS.

CHANUTE.—Mr. Fred L. Krueger is superintendent of the municipal electric light plant, which has been in operation about six months. The plant is said to have cost $40,000.

KENTUCKY.

PADUCAH.—The Board of Public Works has decided to improve the electric light plant.

PRINCETON.—The Princeton Electric Light & Power Company has filed articles of incorporation with the Secretary of State, stating the capital stock to be $25,000.

FT. THOMAS.—Bids are wanted May 31 for wiring buildings; furnishing and installing watt and voltmeters, transformers, arc lamps, and other electric fixtures; erecting necessary pole lines on the reservation, and furnishing the necessary current for electric lighting at this post.

LOUISIANA.

FRANKLIN.—The plant of the Franklin Electric Light & Power Company, Ltd., is now owned and operated by the city. Mr. J. C. Lewis is superintendent.

NEW ORLEANS.—The Consumers' Electric Company states that it has secured a site for the erection of a lighting and power plant which it is proposed to construct immediately, to cost probably $1,000,000.

GRETNA.—The Jefferson Ice & Electric Light Company, which is operating at present a lighting plant, contemplates installing a plant sufficiently equipped to supply lighting current for the towns of Gretna and McDonoghville.

BATON ROGUE.—A charter has recently been granted to Messrs. C. K. Kretz, E. F. Wieck and Turner Bynum for the Capital Light & Power Company, Ltd., with a capital stock of $25,000. Mr. Kretz is president of the company, and Mr. Wieck, secretary and treasurer.

LAKE CHARLES.—The Lake Charles Ice, Light & Water Works Company is making extensive improvements in its plant, comprising the addition of a 300-kw. generator and a 100-light station transformer to its equipment. The company is also installing fifty alternating-current series arc lamps to replace the alternating-current incandescent lights in use heretofore.

NEW ORLEANS.—The New Orleans Railway Company has been awarded a ten-year franchise, dating from September 30, 1905, for lighting the public highways, streets, squares and parks of the city with electricity and for furnishing electric energy for public buildings for the operating of arc and incandescent lamps, motors, pumps, fans, elevators and other public purposes. The franchise calls for the lighting of 476 underground district circuits and for 2151 overhead district circuits. It also includes 200,000 kilowatts of power. The company will receive $200,879 per annum for the service.

MAINE.

DOVER.—The Sebec Lake Railway Company is negotiating for the lease of the surplus water power at the dam of the Dover and Foxcroft water district, for the purpose of operating a power station.

OAKLAND.—The Oakland Electric Company is contemplating the development of a second station involving an expenditure of $100,000. The proposed plant will have a water power capacity of 15,000 horse-power and 750 horse-power steam.

WATERVILLE.—The Ft. Halifax Power Company has been organized at Waterville for the purpose of constructing electric light and power plants in Benton and Winslow. The capital stock of the company is $250,000, and Mr. Harvey P. Eaton, of this city, is president and treasurer.

BAR HARBOR.—The Bar Harbor & Union River Power Company, which is a consolidation of the Bar Harbor Electric Lighting Company, the Ellsworth Electric Ice Company and the Ellsworth Water Company, is now furnishing current for lighting purposes to Seal Harbor and Northeast Harbor.

PITTSFIELD.—On May 3 the Pittsfield Electric Light & Power Company sustained a heavy loss by fire amounting to $50,000, only partially covered by insurance. The building was completely destroyed, but the engine, dynamo and boilers were saved. The saw mill, which was

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run in connection with the plant, was also destroyed. A temporary structure will be erected at once for the lighting system, but it is not yet known whether the entire plant will be rebuilt or not.

MARYLAND.

BALTIMORE.—Bids will be received for installing and maintaining electric lights in Druid Hill Park.

MASSACHUSETTS.

MANSFIELD.—Mr. James E. Arthur is reported as manager of the municipal lighting plant of this place.

ROCKLAND.—Most of the machinery for the sub-station of the street railway company, in course of erection here, has been received and is being installed in the plant.

HOLYOKE.—At a recent meeting of the Board of Aldermen, an order fixing the salary of the manager of the municipal lighting plant went to a first reading by vote of 10 to 9.

SPRINGFIELD.—The new equipment being installed at the power station of the United Electric Light Company comprises a 1000-kw. four-pole generator, direct-connected to a steam turbine of corresponding capacity with a speed of 1800 r.p.m.

WESTFIELD.—Much of the material for the new electric power plant being constructed here has arrived, and the work of stringing the wires has begun. It is expected that the plant will be ready for operation by the middle of July.

CHARLESTOWN.—The two buildings in course of erection at the Charlestown Navy Yard are nearly completed and will be ready within a short time. It is planned to concentrate all of the workshops and offices in the larger building, while the other will be occupied entirely by the large power plant.

INDIAN ORCHARD.—The additions, in course of construction at the plant of the United Electric Light Company here, are nearing completion, and new machinery is to be installed which will increase the capacity of the plant from 2850 to 3800 horse-power. The addition to the building is a one-story brick structure 50 x 40 feet. A 600-kw. generator is to be installed and an underground cable will be run to the new motor-house of the Indiana Orchard Company's mills, which will use about 200 horse-power. Three hundred horse-power will also be conveyed to the Fiberoid Company's plant, which is to be in operation soon.

MICHIGAN.

EATON RAPIDS.—The citizens have voted to issue water and lighting bonds.

BANGOR.—The village of Bangor is now operating its own electric light plant.

DETROIT.—The Public Lighting Commission is making arrangements to install 250 street lights in the city.

WEST BAY CITY.—The citizens recently voted to issue $60,000 for improvements to the water, light and sewerage systems.

BROWN CITY.—Mr. A. B. Granger has been appointed manager of the municipal electric lighting plant, which began operation last year.

DEXTER.—Since the first of the year, the plant of the Dexter Electric Light & Power Company has been owned and operated by the village. Mr. G. M. Hicks is superintendent and chief engineer.

KALKASKA.—The Kalkaska Electric Light Plant, Saw & Planing Mill has been succeeded by the Kalkaska Electric Light & Power Company, of which Mr. A. E. Palmer is secretary.

MANISTEE.—The Manistee Gas & Electric Company is changing over from open arc lamps to enclosed alternating-current series lamps for street lighting.

BOYNE CITY.—The Boyne City Electric Company contemplates increasing its water power and will add a three-phase alternating-current generator to its plant equipment.

ZEELAND.—The Zeeland Water & Light Station will probably install a 250-volt direct-current marine set before next winter to be used after midnight.

MOUNT PLEASANT.—The present officers of the Mount Pleasant Electric Company are as follows: M. O. Newberry, president; A. E. Newberry, vice-president; W. F. Newberry, secretary and manager.

KALAMAZOO.—The Kalamazoo Valley Electric Company, which operates three power plants between Allegan and Jackson, is contemplating the construction of a fourth plant to cost about $200,000.

GRAND LEDGE.—The Grand River Power Company has secured an option on land along the river near Beutch Bridge for electrical purposes. Engineer H. A. Sprague, of Corunna, is said to be interested in the enterprise also.

CENTREVILLE.—The plant of the Centreville Water & Electric Light Company, which has been idle for the past month on account of the damage done by the high water, is again in operation. The town has been in darkness in the meantime.

BOYNE CITY.—The Boyne City Electric Company, which began operation this year, has been purchasing steam power for the operation of its plant. It is now intended to install water power equipment capable of developing 300 horse-power, and a three-phase alternating-current generator will also be added to the plant. Mr. M. W. Swift is superintendent.

ALLEGAN.—Messrs. S. Baker, H. A. Delano, George E. Delano, of Otsego, and F. M. Van Auken, of Allegan, have purchased the plant of The Allegan Light & Power Company, for which they are understood to have paid $15,000. It is expected that several improvements will be made in the equipment, comprising two water wheels, a 300-h.p. engine, boilers, shafting, etc.

MARQUETTE.—Notwithstanding its charges for service are the cheapest in the state, it is reported that the municipal electric lighting plant shows a net revenue of nearly $13,000 for the fiscal year just closed, after full allowance for interest, depreciation, maintenance and a bond payment of $5,000 made from the treasury. The total income was $36,000 and the total operating expenses for the year $18,400. The number of residences lighted is 546 and business houses 282, a total of 828 patrons.

GRAND RAPIDS.—The Grand Rapids Edison Company is a consolidation of the following companies: Edison Light Company of Grand Rapids, Grand Rapids Electric Light & Power Company, Peninsular Light, Power & Heat Company, The Lowell Water & Light Company and the West Michigan Electric Company. The officers of the company are: President and general manager, Mr. Daniel McCool; vice-president, Mr. McGeorge Bundy; secretary and treasurer, Mr. Thomas F. Bechtel; general superintendent, Mr. A. F. Walker; chief engineer, Mr. Waldo Francisco.

ANN ARBOR.—The Michigan Milling Company is preparing to install an electric plant to furnish power to two steam mills; current will also be supplied for lighting the mills. The company owns two other water powers within five miles of Ann Arbor, both of which will probably be utilized for electric power purposes also, making a total capacity of 2000 horse-power. The officers of the company are as follows: Mr. H. S. Dean, president; Mr. W. C. Stevens, vice-president; Mr. Allmendinger, secretary and treasurer, and Mr. N. J. Kyer, manager and purchasing agent.

MINNESOTA.

BREWSTER.—The Village Board is considering the construction of an electric light plant.

PERHAM.—It is reported that bids are wanted for a 200-kw. dynamo, a 250-h.p. engine and a 165-h.p. boiler for the electric plant here.

WARREN.—Mr. W. Haney is now superintendent and chief electrician of the Warren Electric Light & Water Works.

JANESVILLE.—A bond issue will probably be voted on for the construction of an electric light plant and water works which it is estimated will cost $22,000.

CANNON FALLS.—The plans of the Cannon River Electric Power Company for the construction of its power plant have been completed and the contracts will be let at once.

DULUTH.—The Duluth General Electric Company, with a paid in capital stock of $117,000, is a consolidation of the Commercial Light & Power Company and the Hartment General Electric Company. Mr. Thomas Marks is superintendent.

FORT SNELLING.—The equipment of the plant at Fort Snelling, which is owned by the United States Government, will probably be enlarged and the installation of new engines and generators is contemplated; the boiler capacity will also be increased.

MONTEVIDEO.—The incorporation of the Montevideo Electric Light & Power Company, which was referred to in last month's issue, is now an accomplished fact. The capital stock is placed at $60,000 and the incorporators are: Messrs. E. H. Sorlein and Olaus Lende, of Granite Falls, and E. A. Aspines and Lyndon A. Smith, of this place.

MISSISSIPPI.

STARKVILLE.—Mr. J. C. Arnold is now superintendent of the municipal electric light plant.

WOODVILLE.—Bids will be received until June 7 for erecting a system of water works and electric light plant.

CLARKSDALE.—Mr. J. H. Hooks is manager and superintendent of the Clarksdale Water & Light Company.

GREENWOOD.—The citizens recently voted to buy the water, light and sewerage systems at the appraised valuation of $122,586.

COLUMBUS.—Mr. E. W. Waring has been made superintendent of the Columbus Electric Light & Power Company.

INDIANOLA.—The officers of the Indianola Light, Ice & Coal Company are now as follows: President, Mr. W. T. Pitts; secretary and treasurer, Mr. M. L. Pitts; manager and superintendent, Mr. P. H. Williams.

HATTIESBURG.—The Hattiesburg Light & Power Company has closed a contract for $10,000 worth of new machinery and expects to spend more within the next few months in enlarging and improving its plant. Besides the smaller equipment, the order calls for a 500-h.p. engine and a 300-kw. generator. The company is preparing to furnish additional current for commercial lighting purposes and for 150 new street lights.

MISSOURI.

DE SOTO.—Mr. A. T. Vick is superintendent of the Cosumers' Electric Light & Power Company.

UNIONVILLE.—Mr. C. H. Tingley is superintendent of the municipal electric light and water works.

ST. GENEVIEVE.—Mr. Garfield Thomure is now chief engineer of the St. Genevieve Light & Power Company.

BOONVILLE.—Mr. Frederick Dunnavant is chief engineer of the Boonville Electric Light & Power Company.

FARMINGTON.—Mr. O. F. Sessinghaus is now manager of the plant of the Farmington Electric Light & Ice Company.

ST. LOUIS.—Plans for a municipal plant to light by electricity that portion of the city south of Keokuk Street are being considered by the Board of Public Improvements. The plant will probably be situated at the corner of Osage Street and Virginia Avenue. The city is paying at present $59,000 a year for lighting this section by gas.

JOPLIN.—A large electric plant for the purpose of transmitting power to all sections of the mining district of southwest Missouri is to be erected on the banks of Spring River at Lowell, Kans., by Mr. W. J. Sergant, of this city, who has an electric power franchise in Joplin and other cities throughout the mining district. Mr. Sergant has begun the work of building a dam across the river, which is to be 60 feet wide at the base and 12 feet in width at the top. With the river thus harnessed it is said that 700 horse-power can be developed. It will probably be a year before the plant is in operation.

MONTANA.

GLENDIVE.—Mr. Joseph Rice has been appointed chief engineer of the Hughes Electric Light Company.

NEBRASKA.

NELIGH.—The Neligh Mills, of which Mr. S. F. Gilman is the owner, are installing a new dynamo and putting more copper in their lines.

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OMAHA.—The city electrician has recommended the substitution of iron for wooden poles for street arc lamps and the matter is now under consideration.

HUMPHREY.—Mr. Henry Brunning is manager of the electric light plant of the Humphrey Electric Light & Telephone Company. The telephone department is managed by Mr. John Mugg.

ST. EDWARD.—Messrs. D. Hinman and O. H. Flory are proprietors of the electric light and power plant of this city. The operating equipment of the plant consists of a 100 horse-power turbine, two 35 horse-power gas engines and 220-volt direct-current dynamos.

PETERSBURG.—Mr. N. W. Wies, who recently came here from Scribner, has purchased a site in the east part of town and has begun the erection of a building for an electric light plant. Mr. Wies expects to have the plant in operation the early part of June.

BENEDICT.—Mr. W. G. Keeler, owner of the Benedict electric light plant, states that he will have to either put in a larger dynamo to take the place of the present one or install another of the same size as the one now in use, in order to meet the increased demand for service.

HOOPER.—The electric light plant, owned by Mr. William T. Martin, was recently destroyed by fire, leaving the town in almost total darkness. The building will have to be entirely rebuilt, and the machinery was considerably damaged by heat and water. Mr. Martin will rebuild the plant at once.

LINCOLN.—Articles were recently filed with the Secretary of State of Nebraska by the North Platte Electric Light & Power Company, of Colorado, which desires to do business in Nebraska. The company's headquarters are in Denver. The capital stock is $20,000, and the company operates its plants by means of power obtained from the North Platte River.

GALLUP.—The Gallup Electric Light Company was recently organized, with a capital of $50,000, to succeed the Gallup Electric Light & Power Company. The plant equipment of the company consists of three Westinghouse generators, an engine and a boiler. They have the city contract for lighting, and also furnish current for commercial lighting. Gibson, N. M., is lighted by current supplied from this plant.

NEW HAMPSHIRE.

LISBON.—The following are the officers of the Lisbon Edison Electric Light Company: Mr. E. H. Hallett, president; Mr. G. Brummer, vice-president; and Mr. W. W. Oliver, secretary and manager.

CLAREMONT.—Mr. E. C. Baker is now chief engineer of the Claremont Railway & Lighting Company.

BERLIN.—Mr. F. L. Goodnow is now superintendent and chief engineer of the Cascade Electric Light & Power Company.

ALTON.—Mr. Ellsworth H. Rollins is now president of the Alton Electric Light & Power Company, and Mr. Charles H. Davis is secretary and treasurer.

MEREDITH.—The Meredith Electric Light Company is considering a contract with the city to furnish 58 arc lights and 50 incandescent lamps for one year.

NEW JERSEY.

JERSEY CITY.—The United Electric Company of New Jersey, which is now embraced in the Public Service Corporation, has been granted permission to construct subways for electric light, heat and power wires.

TOMS RIVER.—The Toms River & Island Heights Electric Light & Power Company is contemplating adding another unit to its equipment.

WEEHAWKEN.—Bids will be received for furnishing all apparatus, material and labor necessary for the construction of an electric light plant in the sewage station.

BERNARDSVILLE.—The Bernardsville Electric Light Plant has recently placed an order for a new 17 x 18 four-valve engine which will be added to its equipment.

SEA ISLE CITY.—It is reported that the People's Trolley Company is negotiating for the purchase of the Sea Isle City Electric Light, Water & Power Company's plant.

RUTHERFORD.—It is said to be the intention of the Gas & Electric Company of Bergen County to change its transmission lines from the power plan to sub-stations and from 2600 volts two-phase to 6600 volts three-phase.

JERSEY CITY.—The North Jersey Street Railway Company has purchased a large tract of Hackensack River shore front upon which it is proposed to erect a power house at a cost of $400,000 for the buildings and machinery. The new plant, it is said, will furnish power for the entire trolley system east of the Hackensack River and thus do away with many of the smaller power houses. Plans for the new structure are already under way.

NEW YORK.

AKRON.—Mr. H. C. Lewis is now superintendent of the village electric light plant.

SAG HARBOR, L. I.—Bids were received by the village trustees on May 3 for $24,000 electric light bonds.

RICHFIELD SPRINGS.—The president of the Richfield Springs Electric & Power Company is now Mr. M. A. McKee.

PEEKSKILL.—Mr. C. L. Woods has been appointed chief engineer of the Peekskill Lighting & Railroad Company.

ST. JOHNSVILLE.—A new dynamo has been recently installed in the plant of the East Creek Light & Power Company.

BRASHER FALLS.—Mr. B. A. Babcock, owner of the electric plant here, states that he expects to install a new water wheel this summer.

ONEONTA.—Mr. E. E. Arnold, of Providence, R. I., is now president of the Oneonta Light & Power Company, and Mr. John R. Gladding, also of Providence, is treasurer.

CLINTON.—The repairs and additions at the Clinton Electric Light Company's plant are being rushed as fast as possible and it is expected that the plant will soon be ready for operation.

AUBURN.—The Auburn Light, Heat & Power Company, which is controlled by the Electric Company of America, Philadelphia, is to have additional boiler equipment installed at its plant.

ALEXANDRIA BAY.—The village has recently made a new street lighting contract with the St. Lawrence International Electrical Company for an increased number of lights, at a higher price.

FARMER.—The contract for lighting the streets of Farmer has been awarded, and it is expected that an all-night system will be in operation by June 1.

MUNNSVILLE.—Estimates have been completed for the construction of a power plant at Limekiln Falls, near this city. The plant, which will be capable of developing 1000 horse-power, is to cost $45,400.

MIDDLETOWN.—Bids will be received for furnishing 63 arc and 315 incandescent lights of 1200 candle-power and 32 candle-power respectively, for a period of one year from November 1, for lighting the streets every night on an all-night schedule.

MEDINA.—The first penstock and wheel installed at the big dam of the Sweet Power Company were recently tested and found to work in a satisfactory manner. The two remaining penstocks will be put in and the turbines will be ready by the time the full water power has been developed.

SCHENECTADY.—The subway for electric cables, which the Schenectady Railway Company has had in course of construction since October, 1902, is about completed, and it is expected that before fall all the wires will be underground, including the trolley feeding cables, those supplying the sub-stations on the Troy and Albany lines and all the wires supplying lighting current to the city.

ROCHESTER.—The merger of the Rochester Gas & Electric Company, the Rochester Railway Company and the Rochester Light & Power Company, which has been under discussion for some time has at last been consummated. The name of the consolidated companies is to be the Rochester Railway & Light Company. Its capital stock will be $3,000,000 preferred and $6,500,000 of common stock.

HOOSICK FALLS.—At its annual meeting held recently, the Hoosick Falls Electric Company decided to rebuild the dam at its power station and work will be commenced immediately. The following officers were elected for the ensuing year: Frank H. Viele, Worcester, Mass., president; Mr. Derick L. Hall, Hoosick Falls, vice-president; Mr. W. H. Tylee, Worcester, secretary and treasurer, and Mr. Ralph D. Smith, this city, general manager. The officers, with Mr. James Henry, Corning, N. Y., constitute the Board of Directors.

CASTILE.—The municipal electric light plant here, although a relatively small one, made an extremely good showing last year. The city authorities have voted an appropriation of $1,200 to cover a deficiency due to expenditures for plant construction last year which had not been covered in the previous appropriation, and have also issued bonds for $40,000 to cover a water system. Bids have already been advertised for the water plant and the construction will begin just as soon as the bids can be opened and the contract awarded. Mr. George W. Newman is superintendent of the plant.

SCHENECTADY.—A rather noteworthy achievement was accomplished here recently, when the entire electric current which lights the city and furnishes power for nearly all the manufactures was successfully transferred from the old substation in Dock Street to the new one. None of the lighting interests in the city were affected, and as the change was made about 1 A. M., when travel is light, the few trolley lines in operation at that time experienced but little inconvenience. The new station is now complete in every respect, and besides its lighting and industrial power service, it will furnish power for the operation of the new electric pump which is being installed at Rotterdam.

NORTH CAROLINA.

MAXTON.—Mr. John H. Cook is now president of the Carolina Electric Company.

KINSTON.—Contracts have been awarded for water works, a sewerage system and an electric light plant.

RALEIGH.—Reports state that the Raleigh Electric Company is preparing to construct street railway lines.

SOUTHERN PINES.—The electric light plant is owned and operated by Mr. R. L. Chandler under the style of R. L. Chandler Electric Light Plant.

KENTVILLE.—The Kentville Electric Light & Power Company is planning to install a small engine and dynamo to carry the load after 10 o'clock.

SALISBURY.—The plant of the Salisbury Gas & Electric Light Company was recently transferred by the company to the Salisbury Electric Railway Company.

SANFORD.—The Sanford Electric Light & Power Company is contemplating extending its service to Jonesboro, two miles distant, where 500 lights will be installed and supplied with current.

CONCORD.—It is expected that the municipal electric light plant will change over from direct to alternating current in the course of a few months. Sixty arc lights will be installed and 1500 incandescent lamps, as well as the necessary machinery to furnish the required current for the additional service.

LEXINGTON.—The electric light plant of the Lexington Water & Light Company, which was burned out, is to be replaced by a new plant for lighting purposes and water works will be added. The company has recently been operating two direct-current dynamos for lighting the church and a few stores.

NORTH DAKOTA.

CARRINGTON.—Mr. Karl H. Smith is chief engineer of the Carrington Electric Light Plant.

CASSELTON.—The electric light plant, which was formerly operated by the city, is now owned by Mr. B. A. Tenney.

DICKINSON.—Messrs. Hughes & Deiters, proprietors of the electric light plant, are contem-

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plating installing a new tubular boiler some time during the coming summer.

OHIO.

NEWBURG HEIGHTS.—Bids are wanted for supplying the village with street lights.

CHICAGO JUNCTION.—The municipal electric plant is making general repairs to its lines.

MAYVILLE.—Mr. George E. Bamble is now superintendent and chief engineer of the electric light plant of Mayville.

DELAWARE.—Mr. E. E. Neff is now president of the Delaware Electric Light & Power Company.

BRADFORD.—A. W. McCune, G. S. Arnold and others recently incorporated the Bradford Electric Light Company with a capital of $10,000.

NAPOLEON.—Bids for $25,000 improvements to the water works and lighting plant have been called for.

NEWARK.—The Citizens' Electric Light & Power Company is contemplating the addition of one 600-kw. generator, a Corliss engine and two boilers to its plant equipment.

BELLAIRE.—The Belmont Electric Light & Power Company contemplates making additions and improvements to the power plant that will nearly double the capacity.

WILMINGTON.—The Wilmington Water & Light Company is erecting and equipping an entire new plant which will be ready for operation by September 1.

DICKINSON.—Messrs. Hughes & Deiters, who own the Dickinson electric light plant, expect to install a new tubular boiler some time during the summer.

BOWLING GREEN.—Messrs. J. H. La Farree and J. H. Ridley are now managers of the Lake Erie, Bowling Green & Napoleon Railway Company, which is successor to the Bowling Green Electric Light & Power Company.

SYCAMORE.—The following are the present officers of the Village Electric Light Plant: President, John Grafton; secretary, E. V. Ingerson; treasurer, G. A. Klahn; chief engineer, L. E. Patrick.

EATON.—The Eaton Light & Artificial Heat Company, which recently absorbed the stock of the local Electric Light, Power & Ice Manufacturing Company, is making preparation for the erection of a new electric plant.

LOWELLVILLE.—A new electric light plant is to be constructed at Newton Falls the coming summer. The contract for wiring the specifications has been let to Mr. H. B. Lee, electrician, of this city.

TOLEDO.—The council is advised by the Mayor in his annual message to empower the Board of Public Service to advertise for bids for installing a lighting system of 2000 arc lamps, to be paid for by the city in monthly payments without a bond issue.

NEWTON FALLS.—Press reports state that bids have been received by the city council for an electric light plant. The successful bidder will be given the contract for ten years for lighting the village and a twenty-year franchise for commercial lighting and furnishing power.

SHAWNEE.—Mr. C. P. Bauman, of Canal Winchester, Ohio, is now president of the Shawnee & Strainsville Electric Light Company; Mr. L. D. Bonebrake, of Columbus, is vice-president, and Mr. O. L. Bowers, Shawnee, treasurer and manager.

FREMONT.—The officers of the Fremont Yaryan Company, which owns and operates a heating and lighting plant here, are as follows: T. H. Jungk, president; E. S. Thomas, vice-president; J. W. Forsythe, secretary and treasurer, and W. B. Jessop, superintendent.

GALLIPOLIS.—The Gallipolis Electric Light Company has been consolidated with the Gallipolis Gas & Coke Company, and the business will be continued under the name of the latter company. Mr. C. F. Stockhoff is president; Mr. C. D. Kerr, secretary; Mr. C. W. Henking, treasurer; Mr. C. L. Steenberger, manager and superintendent.

CARDINGTON.—The electric light plant, formerly owned by G. M. Schambs, is now operated by the Cardington Electric Light, Heat & Power Company, of which Mr. W. P. Vaughan is president; Mr. W. E. Hull, vice-president; Mr. A. E. Curtis, secretary; Mr. J. W. Glauner, treasurer, and Mr. G. M. Schambs, manager.

DAYTON.—The report of the light committee and the city solicitor, declaring the legality of the contract between the city and the Dayton Light Company, has been adopted by the Board of Public Service. It was stated in our May issue that Mayor Snyder had vetoed the ordinance granting the franchise.

COLUMBUS.—While one of the five engines in the power house of the Columbus Railway & Light Company was undergoing repairs recently, another engine became disabled, necessitating shutting off the power until the latter could be repaired. This required a couple of hours, during which time traffic was interrupted.

FARGO.—The Fargo Gas & Electric Company has been consolidated with the Fargo Edison Company under the name of the Union Light, Heat & Power Company. The officers of the new company are as follows: President, William Mainland, Oshkosh, Wis.; vice-president, J. W. Smith, Fargo; treasurer, S. Mainland, Green Bay, Wis.; manager, O. G. F. Markus, Fargo.

MECHANICSBURG.—The Mechanicsburg Light & Power Company was recently organized with a capital of $9000. The company is composed of Messrs. T. J. and J. R. Long and Mr. E. J. Ward, and has secured the city lighting contract. At present it is furnishing only lighting current, but it is expected that a direct-current day circuit for power purposes will soon be in operation.

OKLAHOMA TERRITORY.

EL RENO.—The El Reno Electric Light & Telephone Company has been absorbed by the El Reno Lighting, Heat & Power Company. The officers of the new company are as follows: President, John A. Masters; vice-president, B. S. Trimble, of Jamestown, N. D.; secretary and treasurer, Frank Casey; chief engineer, H. T. French.

ENID.—The Chickasha Electric & Gas Company was recently incorporated with a capital of $450,000 by J. M. Dodson and H. H. Watkins, both of this city.

NORMAN.—It is reported that the Norman Milling & Grain Company will install another 125 horse-power high-pressure boiler at its plant this season.

OREGON.

ANTELOPE.—The question of constructing an electric light plant here is being considered by the citizens.

KLAMATH FALLS.—Mr. O. B. Bates is now superintendent of the Klamath Falls Light & Water Company.

STAYTON.—The Stayton Electric Light Company states that it is contemplating the addition of a 250-volt booster to its equipment.

ALBANY.—Mr. R. B. Martague has been appointed manager of the Albany Canal & Water Company, successor to the Albany Electric Light, Power & Telephone Company.

INDEPENDENCE.—It is the intention of the Independence & Monmouth Electric Light & Water Company to install a new dynamo and a step-up transformer at its power plant.

PORTLAND.—According to recent reports, it is the intention of the Portland General Electric Company to make extensions to its power plant involving an expenditure of about $250,000.

SALEM.—The following are the officers of the Salem Light & Traction Company: Mr. J. J. Henry, president and treasurer; Mr. H. C. Stoddard, superintendent, and Mr. Frank Johnson, chief engineer.

SUMPTER.—The Sumpter Light & Power Company is now officered as follows: President and manager, Robert E. Strahom, Spokane, Wash.; vice-president, R. J. Donson, Spokane; secretary and treasurer, A. G. Smith, Spokane; superintendent, J. W. Ball, this city. Mr. Ball states that work on the company's new plant will commence immediately.

ROSEBURG.—The Umpqua Water, Light & Power Company was organized March 1 by consolidating the Douglas Electric & Water Company and the Roseburg Water & Light Company. The capital of the company is $50,000, and the officers are: President, Mr. Fred J. Blakeley; secretary, Mr. Dexter Rice; treasurer and manager, Mr. T. S. Sheridan, and superintendent, Mr. F. H. Farrar.

BAKER CITY.—The Rock Creek Power & Transmission Company is installing a plant near this place. The equipment includes two 400-kw. three-phase 60-cycle G. E. generators, direct-connected to 900-h.p. water wheels with a speed of 450 r.p.m., and three 300-kw. transformers of the three-phase type. Current is to be transmitted to Baker City, a distance of 27 miles, and will also be furnished for power purposes to adjoining mining districts 17 miles in another direction. The plant is expected to be in commercial operation this month.

PENNSYLVANIA.

CARBONDALE.—The Hendrick Light & Power Company is incorporated with a capital of $5000.

NEW CASTLE.—A $75,000 bond issue is to be made by this city for the erection of a municipal electric light plant.

CORRY.—The Corry City Electric Light Company is contemplating the construction of a new power house.

SPANGLER.—Articles of incorporation have been filed by the Spangler Electric Light, Heat & Power Company with a capital of $5000.

JERMYN.—The Household Electric Light, Heat & Power Company is arranging to put in an extension of about 1½ miles of line shortly.

SHENANDOAH.—Local press reports state that bids are wanted by the Borough Council for furnishing 60 or more arc lights of 2000 candle-power.

BROOKVILLE.—The plant equipment of the Solar Electric Company will probably be increased shortly by the addition of a dynamo and a 150 horse-power engine.

MECHANICSBURG.—Mr. M. C. Kennedy is president of the United Electric Company; Mr. W. L. Ritchey is secretary and treasurer, and Mr. W. E. Guthrie is superintendent.

FRANKLIN.—The following are the officers of the Franklin Electric Company: President, Mr. W. J. Bleakly; secretary, Mr. H. A. Clawson; treasurer, Mr. O. D. Bleakly, and superintendent, Mr. B. F. Ott.

TARENTUM.—The city authorities are contemplating improvements to the municipal electric light plant, which, it is estimated, will cost from $10,000 to $12,000. They are also considering the adoption of the meter system.

EASTON.—The plant of the Lehigh Power Company, which has been idle since it was damaged by the floods last fall, has been purchased by Morris, Brother & Richardson, of Philadelphia, in consideration of $35,000.

DANVILLE.—It has been voted to establish a municipal light plant, and the Light Committee has been instructed to obtain estimates of the probable cost and maintenance of same prior to asking for bids.

CONSHOHOCKEN.—The Conshohocken Electric Light Company has secured a contract from the borough of West Conshohocken to light the streets of the borough at $15 an incandescent light. The contract stipulates that the borough shall exempt the company from pole tax and expect no reduction for the time lamps are out, unless the company is directly responsible.

MANHEIM.—The Manheim Electric Light, Heat & Power Company has been consolidated with the Lancaster Valley Electric Light Company, the officers of which are: President, Mr. A. W. Mentzer, Ephrata; manager and superintendent, Mr. F. E. Keiff, Manheim, and chief engineer, Mr. J. Weaver, Manheim.

WAYNESBORO.—The Waynesboro Electric Light & Power Company has increased its capital stock from $15,000 to $30,000. The officers of the company are as follows: Mr. W. Z. Minick, president; Mr. John M. Wolff, vice-president; Mr. E. C. Stull, secretary; Mr. M. E. Sallenberger, treasurer; Mr. J. F. Geiser, superintendent.

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DAWSON.—The Dawson Electric Light & Power Company is now owned and operated by the West Pennsylvania Railway & Lighting Company, of Pittsburg, of which Mr. W. S. Kuhn is president and manager; Mr. J. B. Van Wagener, vice-president, and Mr. H. F. Bomard, purchasing agent, all of Pittsburg; Mr. E. St. Clair Clayton, Dawson, is superintendent of the plant.

SOUTH CAROLINA.

ROCK HILL.—The Catawba Power Company is extending its lines to Charlotte and will supply current for power and lighting purposes.

BENNETTSVILLE.—The city authorities are considering the extension of the incandescent circuit of the municipal electric light plant to this place.

CLINTON.—The City Council is said to be considering a proposition made by some Washington capitalists to put in an electric light and water works system here. The proposition includes about forty hydrants and sixty lights, for which the parties ask $2000 and a forty year franchise, the town to have the privilege of purchasing the plant at the expiration of ten years or any five years thereafter.

GLEN CAMPBELL.—The Giant Electric Light, Heat & Power Company, which was organized the first of April, is furnishing electricity for lighting purposes to Burnside, Arcadia, Gipsey and Glen Campbell. The company is making arrangements to supply current for power purposes also. The officers are: Mr. S. J. Smith, president; Mr. Thomas Bellis, vice-president; Mr. A. M. Riddell, secretary; Mr. C. W. McCrady, treasurer, and Mr. D. H. Stroup, superintendent, all of this city.

SOUTH DAKOTA.

MADISON.—Mr. William Roche is now superintendent of the municipal electric light plant of Madison.

SALEM.—The officers of the Salem Milling, Lighting & Heating Company are: L. V. Schnider, president; W. S. Westfall, vice-president; H. C. Torry, secretary and manager; L. S. Tyler, treasurer.

IROQUOIS.—The equipment of the village electric light plant will probably be increased by the installation of a second dynamo, which will enable them to utilize all of the power furnished by the water wheel.

LEAD.—Mr. J. D. S. Rumsey, of Rochester, N. Y., is president of the Belt Light & Power Company; Mr. V. T. Price is vice-president; Mr. J. B. Baker, secretary and manager, and Mr. J. H. Fuller, chief engineer.

TENNESSEE.

JEFFERSON CITY.—The Jefferson City Electric Company states that in the near future its plant will be operated by steam.

BROWNVILLE.—The Burt-Smith Company is adding another dynamo to its plant equipment and extending its lines.

HUNTINGDON.—The electric light service has been very much improved by the installation of a new Corliss engine at the city electric light plant.

NASHVILLE.—The Southern Electric Company, with an authorized capital stock of $20,000, has been recently incorporated by Felix Shwab, W. K. Webb, F. O. Watts, W. O. Vertrees and W. M. Bowles.

CHATTANOOGA.—A bill authorizing the construction of a large power plant at the "suck" on the Tennessee River, has passed both Houses of Congress and is now a law. The bill as amended and passed grants the privilege of erecting the plant, first to the city of Chattanooga, and should the city not undertake the work or express its intention of so doing within four months, then the privilege is granted to Messrs. C. E. James and J. C. Guild and associates, who will be allowed eight months in which to declare their intention of accepting it. The cost of the dam and locks, together with the land bordering on the river at that point to be used in connection with the power plant, is estimated to be about $2,000,000. This is all to be provided for by the parties erecting the plant, and upon the completion of the work the dam and locks are to be deeded to the Government, in consideration of which the Government guarantees the privilege of using the water power thus secured for the purpose of operating an electrical power plant.

TEXAS.

HOUSTON.—Mr. Clarence George has been appointed city electrician.

SULPHUR SPRINGS.—B. Ashcroft & Sons now own and operate the electric light plant of this place. Mr. C. P. Smith is superintendent.

McKINNEY.—The McKinney Electric Light & Motor Company is now being managed by Mr. L. A. Scott, who is also president of the company.

CALDWELL.—Cypher Brothers, of Austin, are contemplating the construction of an electric light and ice plant here at a cost of about $10,000.

LADONIA.—The City Electric Light & Water Works Company is increasing the voltage of its circuits to 104 and putting in new transformers.

TERRELL.—The Terrell Electric Light Company is reported to be increasing the amount of copper on its lines.

CARTHAGE.—Mr. John Whitney, proprietor of the electric light plant, is planning to give the plant a general overhauling and may possibly install a more economical prime mover.

MACOGDOCHES.—Mr. E. E. Branch is president of the Macogdoches Light & Power Company; Mr. K. P. Branch is vice-president, and Mr. O. E. Hubbard is secretary and manager.

LEONARD.—The Leonard Electric Light & Ice Company was recently organized for the purpose of erecting an electric light and ice plant. Mr. Y. T. Manning is president, and Mr. L. H. Saunders, secretary of the company.

THURBER.—Mr. Thomas R. Termont is now superintendent of the Texas Pacific Mercantile & Manufacturing Company, which furnishes alternating current for three arc lamps and 1500 incandescent lights.

CLARENDON.—Two franchises for the operation of electric light plants here have been granted by the city council. One was to Chase & Company, who have been operating a plant in this city for some time, while the other was granted to James Trent, who will immediately install a plant.

DECATUR.—The Decatur Electric Light Company is now known as the Moore Milling Company, with a capital stock of $20,000 fully paid up. The officers, all of Decatur, are: President, Mr. J. J. Perkins; vice-president, Mr. C. M. Moore; chief engineer, Mr. J. W. Moore.

AMARILLO.—The Amarillo Light & Water Company has been succeeded by the Amarillo Water, Light & Power Company, of which Mr. L. W. Chase, of Cleburne, is president; Mr. W. F. Ramsey, Cleburne, vice-president; Mr. A. L. Chase, of Amarillo, secretary and manager, and Mr. John K. Bryden, of Pittsburg, Pa., treasurer.

AUSTIN.—It was stated recently that an offer might be made to rebuild the Austin dam on the basis of revenues from the water and light plant for a number of years. Mr. R. H. Ingersoll, who is interested in water power plants in other states, has been here looking over the situation, and it is thought he may submit a proposition before long.

HOUSTON.—The addition to the plant of the Houston Light & Power Company has been completed and the machinery is being installed. The equipment includes three 450-h-p. Babcock & Wilcox boilers, a turbine engine and dynamos. Wires are being extended to nearly all parts of the city and the plant will be ready for operation by September 1.

PORT ARTHUR.—The Port Arthur Light & Power Company has been consolidated with the Port Arthur Water Company under the name of the latter. The joint company is operating on a capital stock of $200,000, and the following are its officers: President, Mr. George M. Craig; vice-president, Mr. H. Y. Arnold; secretary, Mr. R. H. Woodworth; treasurer, Mr. Frank Woodworth; manager and superintendent, Mr. George A. Taylor.

UTAH.

FOUNTAIN GREEN.—The Big Springs Electric Company may extend its lines twelve miles further in order to furnish current for lighting purposes to Ephraim.

SALT LAKE CITY.—The Utah Light & Railway Company has arranged for an additional 1000 horse-power of current with the Bear River power plant, in anticipation of the demands of the next fall and winter. It is expected that another 1000 horse-power will be required in the course of another year.

VERMONT.

ESSEX JUNCTION.—Mr. S. A. Brownell is now president and manager of the People's Electric Light & Power Company's plant of this place.

BARRE.—The People's Lighting, Heating & Power Company, an organization composed of citizens of this city and Burlington, is arranging to construct a large gas plant soon.

MANCHESTER. The Manchester Light & Power Company is understood to be negotiating for the purchase of the Vail Light & Lumber Company's plant.

RUTLAND.—The Rutland City Electric Company recently installed a new $4000 switchboard at its electric light station. The board contains eleven panels and is equipped with the latest appliances.

BURLINGTON.—The Street Committee is arranging for the plans and specifications of the municipal lighting plant for which the city is bonded for $58,000. It is estimated that a plant capable of developing 250 kilowatts will meet the present requirements. Of this, 125 kilowatts will be used for lighting the public highways and 25 kilowatts for the lighting of buildings. The plant will be housed in a brick building to cost $5,000, and space will be allowed for the installation of two extra units when they become necessary.

VIRGINIA.

WEST POINT.—Recent reports state that an electric light plant is soon to be installed here.

FREDERICKSBURG.—Mrs. E. C. L. Ficklen is now owner of the Rappahannock Electric Light & Power Plant; Mr. E. M. Greene is superintendent.

CULPEPER.—The Culpeper Electric Light Company expects to erect a 6-ton ice plant which will be operated by power supplied from its present plant.

BIG STONE GAP.—The electric light plant is now owned by the Wise Electric Company, of which Mr. C. C. Cochran is president and manager, and Mr. S. R. Cochran is secretary and treasurer.

MARTINSVILLE.—The council is considering the installation of an electric light and power plant capable of developing 1000 horse-power, to furnish current for lighting the town and supply power for industrial purposes. The plant will be operated by water power obtained from Smith River, about a mile south of the town, and will probably cost $70,000.

WASHINGTON.

ABERDEEN.—Mr. E. A. Bradner has been made superintendent of the Gray's Harbor Electric Company.

MONROE.—The Monroe Water & Light Company has been organized to construct and operate water works and an electric light plant.

PALOUSE.—The Palouse Electric Company is asking the City Council for a 25-year franchise. The matter has been referred to the committee.

WHATCOM.—The local lighting company has been awarded a three-year lighting contract by the City Council.

OLYMPIA.—The Olympia Light & Power Company has been granted a franchise for the extension of its car lines.

ABERDEEN.—It is understood that local capitalists are considering making an application to the City Council for an electric light franchise.

PORT ANGELES.—Messrs. G. G. Teachman and David Ferguson are manager and chief engineer respectively of the City Electric Light Company.

BELLINGHAM.—The city council is considering the purchase of the lighting plant now operated by the Bellingham Bay Improvement Company.

SEATTLE.—The construction of an interurban line between Seattle and Everett, a distance of

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about 38 miles, will be begun about the first of July.

SEATTLE.—The municipal electric light plant, located on Cedar River, which is expected to be ready for operation in August, is nearly completed and work on the construction of the pole line from the power house to this city is already under way.

NORTHPORT.—The Northport Electric Light Company's plant was destroyed by fire on the morning of May 4. The loss on switchboard, machinery, supplies and building will approximate $4000. Mr. Robert Morrill is owner and manager of the plant.

VANCOUVER.—It has been decided to install an electric light plant at the post here and it is probable that the Vancouver Electric Light Company will receive the contract for a term of years. The company is said to be making arrangements to install a 500-h.p. engine to supply the necessary power.

WEST SEATTLE.—The city has voted bonds for $18,000 to build and equip an electric street car line, power for which will be furnished by one of the several large Seattle companies. One line will be built, connecting at the Sound with the ferry boats and running through the town to the western city limits.

SEATTLE.—The City Council is considering the advisability of operating electric sprinkling cars in the congested down-town districts. The Seattle Electric Company, it is understood, has offered to run the cars at cost, an ordinance for the purchase of which will be introduced at the next meeting.

WATERVILLE.—The contract for the complete installation of the Waterville transmission plant, to be erected on the Enteat River, has been awarded to Mr. George Nixon, of Spokane. The available water power is 3000 horse-power and the present development is for 250 horse-power. Three-phase current at 6600 volts will be transmitted from the power house to the town, a distance of nine miles.

SPOKANE.—The Washington Water Power Company recently secured the contract for 500 horse-power of electricity to operate all of the machinery of the Morning mine, three and a half miles above Wallace, Idaho, on the Cœur d'Alene River at the mouth of Grouse Gulch. Preparations are being made to extend the line the necessary four miles, and a sub-station will be built at Grouse Gulch, which will be in operation by September 1, when the contract goes into effect. The contract is for a minimum of 300 horse-power for five years. The company also has contracts for a minimum of 1800 horse-power a year among other mines of the Cœur d'Alenes, and from Spokane Falls is operating machinery in the Standard, the Hecla, Mammoth, Bunker Hill and Sullivan, and the Last Chance, besides several smaller mines.

SEATTLE.—The Snoqualmie Falls & White River Power Company is a consolidation of the Tacoma Cataract Company, the Snoqualmie Falls Power Company and the Seattle Cataract Company, with a capital stock of $3,000,000 all paid in. The company's officers are: Mr. Charles H. Barker, president and manager; Mr. O. D. Colvin, first vice-president; Mr. E. C. Newfelder, second vice-president; Mr. Thomas B. Hardin, secretary; Mr. Lester Turner, treasurer; Mr. John Harrisberger, superintendent. The company furnishes electricity for lighting purposes to Tacoma, Issaquah, Renton and Auburn, besides Seattle.

SEATTLE.—The Board of Public Works has granted the Citizens' Light & Power Company the privilege of extending its lines throughout what is known as the Belmont Avenue district. The cost of this improvement is estimated at about $50,000. It is said that the company is planning to make other extensive additions to its plant. Other local light and power companies are contemplating the expenditure of large sums of money in improvements during the coming season, and it is expected that within a short time the Seattle Lighting Company will install its mains in the Renton Hill, Beacon Hill and other residence localities.

CHELAN.—Mr. W. J. Long. of the Chelan Water Power Company, is said to be interested in the promotion of a new electric railway enterprise to be known as the Big Bend Railway Company. Mr. A. Bettes, of Spokane, Wash., and Mr. J. E. Sullivan, of Coeur d'Alene, Idaho, who are the promoters and builders of the line from Coeur d'Alene Lake, are also interested in the new undertaking. The line will run from Rock Island on the Great Northern Railroad through the immense wheat fields of the Big Bend country to Chelan, on the Columbia River. Twenty miles is to be constructed this year, and the complete line is to be in operation a year from next fall.

WEST VIRGINIA.

WHEELING.—The Belmont Electric Light & Power Company has in contemplation important additions and improvements which will nearly double the capacity of its plant.

RICHWOOD.—The Richwood Light & Power Company states that it is in the market for 2500 16-c.p. incandescent lamps and 14 arc lights, with the necessary electric generating machinery for operating the same.

MORGANTOWN.—It is reported that on May 1 the Union Utility Company reduced its rates for lights from 12 to 10 cents per 1000 watts. A discount of 5 per cent will be allowed on all bills over $3 per month, and the minimum charge of 75 cents per month to each customer will be continued.

WISCONSIN.

LAKE GENEVA.—The Equitable Electric Light Company is constructing a mile of new line.

WITTENBERG.—Bids are wanted for the construction of an electric light plant.

ELKHORN.—Mr. Paul Prisk has been appointed superintendent of the city electric light plant.

TOMAH.—Mr. A. H. Nelson is now manager and chief engineer of the local electric light plant.

GLIDDEN.—Reports from this city state that there is a good opening for an electric light plant there.

PORTAGE.—Mr. R. E. York is secretary and treasurer of the Portage Electric Light & Power Company.

MENOMONEE FALLS.—The city council is said to be interested in the construction of an electric light plant at this place.

LAMARTINE.—The Lamartine Heat, Light & Power Company is contemplating the erection of a new stone building, 30 x 400 feet.

IRON RIVER.—The Iron River Water, Light & Power Company will change shortly from steam to water power for operating its plant.

ELKHART LAKE.—The Sheboygan-Elkhart Lake Railway & Electric Company is arranging to furnish lighting current to a neighboring town.

BURLINGTON.—A meeting is soon to be held for the purpose of voting on the issue of $27,000 bonds for the construction of an electric light plant.

EAU CLAIRE.—The electric light committee, of which Mr. Emmet Horan is chairman, is considering the question of installing a municipal electric light plant.

GREEN BAY.—The Green Bay Light & Power Company has started work on the extensions to its buildings and plant, which have been contemplated for some time.

WAUKESHA.—Mr. F. A. Dombrook, chief engineer of the Milwaukee Electric Railway & Light Company, recently delivered a lecture on "Electric Power and Transmission" before the local order of stationary engineers.

CANADA.

BERLIN, ONT.—The plant and property of the Berlin Gas Company have been acquired by the town of Berlin.

NIAGARA FALLS, ONT.—The Niagara Falls electric light plant is now owned and operated by the city council.

NELSON CITY, B. C.—Bonds have been issued for the erection and equipment of a 3000-h.p. plant for power and lighting purposes.

EXETER, ONT.—The Exeter Electric Light Plant, which is owned by C. B. Snell, is arranging to install more town lights.

THREE RIVERS, QUE.—The North Shore Power Company is now supplying lighting current to Cape Madelaine and St. Narcisse.

SHELBURNE, ONT.—The electric light plant is now owned by Mr. James Pickering. Mr. Pickering has the city lighting contract and also furnishes current to Millbrook for lighting purposes.

PRINCE ALBERT, N. W. T.—The town of Prince Albert is making extensions to its plant and equipment. These include an engine, boiler and dynamo.

PAKENHAM, ONT.—The Pakenham electric light plant is now owned and operated by the Down Milling Company, Ltd., of which Mr. H. S. Dowd is president.

SELKIRK, MAN.—The plant of the Selkirk Electric Company, Ltd., is now owned by Mr. Robert Oakland. The plant generates current for both lighting and power purposes.

RENFREW, ONT.—A. A. Wright & Co. have been succeeded by the Renfrew Electric Company, of which Mr. A. A. Wright is president and manager; Mr. W. A. Wright is secretary, and Mr. G. Fyfe is superintendent.

AURORA, ONT.—Mr. W. H. Birchard is now proprietor of the plant formerly owned by the Aurora Electric Light Company. The equipment consists of a condensing engine and an alternating current dynamo. Mr. Birchard has the contract for the city lighting.

OTTAWA, ONT.—Reports state that the question of putting the overhead wires underground has been settled, and the Consumers' Electric Company is preparing to expend about $30,000 in laying conduits for this purpose from the Chaudiere to its power station on Maria Street.

SHAWINIGAN FALLS.—The Shawinigan Falls Water & Power Company recently let the contract for the construction and installation of a new transmission line for transmitting electrical power generated by the company at its power house at the Falls to Montreal, a distance of 85 miles.

ST. CATHARINES, ONT.—The Lincoln Electric Light & Power Company is installing in its plant a new 300-kw. three-phase generator for power and lighting purposes, and is building a three-phase line to the power house of the Hamilton Cataract Power, Light & Traction Company for the lighting of the new Welland Canal.

MEXICO.

COLIMA.—The contract is said to have been let for the construction of the electric lighting system in this city.

PUEBLA.—Sr. Ernesto Gutierrez, of Mexico City, is now manager of the Compania Anonima del Alumbrado Electrico Estacion de Nopolito.

JALAPA, VERA CRUZ.—The Jalapa Railroad & Power Company has extended its lines to Xico Ciateper and Teicelo and is now supplying lighting current to those towns.

LAS JUNTAS.—The Campania Maustral de Guadalajara, which at present is operating a 2000-h.p. hydraulic plant at this place for the purpose of transmitting current to Guadalajara, chiefly for lighting purposes, is preparing to increase the capacity of its plant by the addition of new equipment capable of developing 2000 horse-power.

SILAO.—Mr. George B. Hyde, an American, now a resident of this place, has made application for permission to erect three electric power plants in the State of Peubla to furnish power for operating machinery in the mines located in the Tetela de Ocampo district. The Zempoala River will furnish the water power for the plant.

MEXICO CITY.—The large water power and electric transmission plant, which is being constructed by the Mexican Light & Power Company in the State of Puebla, 90 miles from this city, will have an initial capacity of 45,000 horse-power. In order to secure a suitable site for the necessary reservoir, it was found necessary to move a town of 1000 inhabitants. The company purchased the entire town and all the buildings were razed and reconstructed on the new site.

HOSTOTITAQUILLO, JALISCO.—Francisco Brenna, of Mexico City, has secured the necessary concession from the State Government for the erection of a hydraulic plant on the Rio Grande de Santiago, for the purpose of supplying towns in the vicinity with current for lighting purposes. The franchise permits the utilization of 15,000 liters of water per second.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

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A LARGE PARISIAN ELECTRIC GENERATING PLANT.

THE MOULINEAUX POWER STATION IN PARIS.

BY FRANCIS PAUL.

Among the large stations which have been erected in Paris within the last few years, the Moulineaux plant, which lies in the suburbs of the city, is one of the largest and best equipped. This station is controlled by the Compagnie des Chemins de Fer de l'Ouest and was built and is operated by the Compagnie Generale de Traction conjointly with the Societe Industrielle d'Electricite, which represents the Westinghouse interests in France. The latter company installed all the electrical apparatus, while the engine and boilers were supplied by French companies. The Moulineaux plant supplies current for lighting circuits and for operating the new electric railroad which runs from the Invalides Station in Paris to Versailles, as well as different traction lines in the city. The station also delivers current to a part of the Metropolitan circuits.

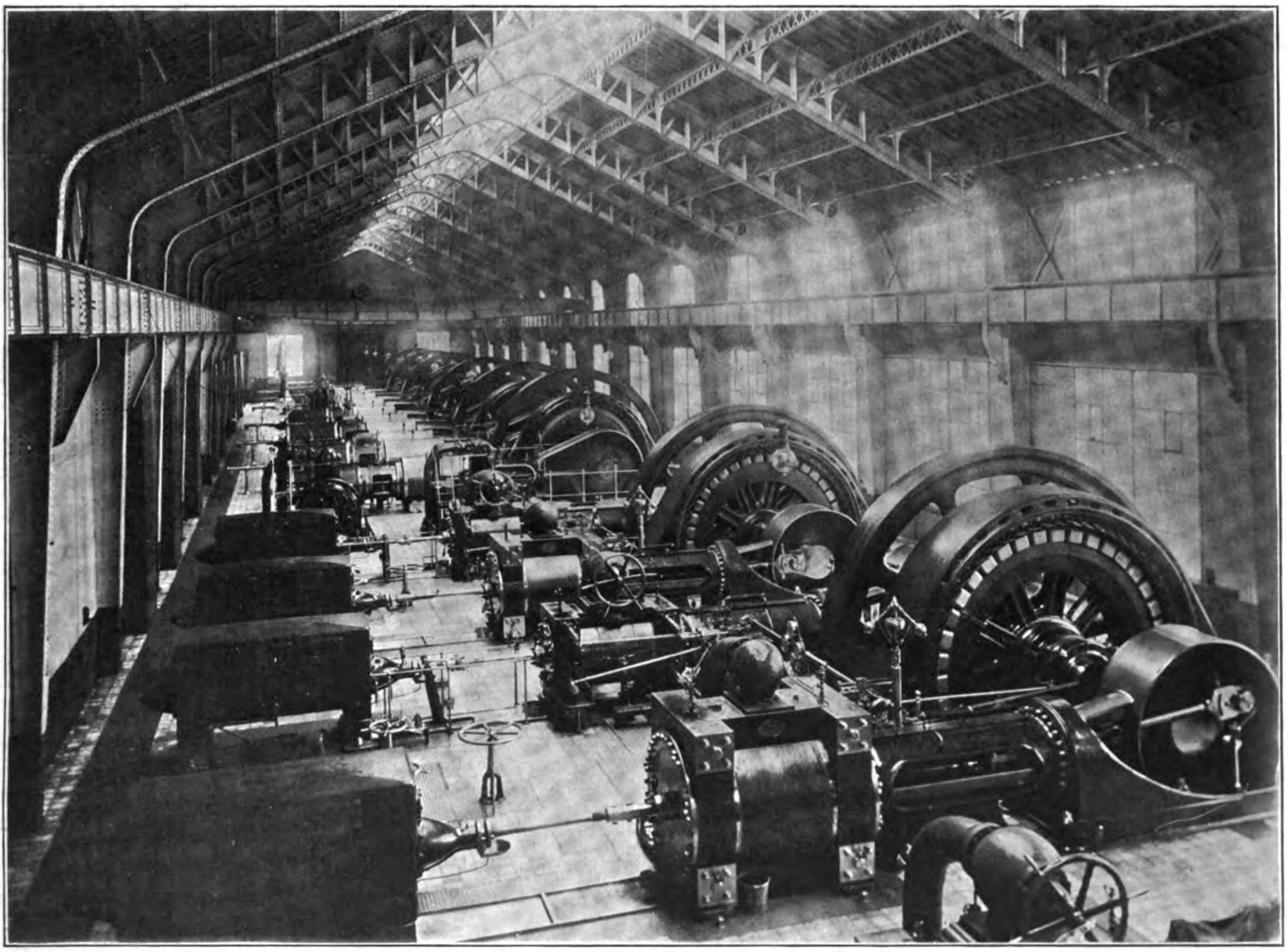

FIG. 1.—GENERAL VIEW OF ENGINE ROOM, MOULINEAUX POWER STATION.

The plant occupies a large plot of ground lying on the banks of the Seine just outside the city. It has good railroad facilities, so that coal can be easily supplied, and the cars are run in directly from the railroad. Coal can also be taken from barges on the Seine. The principal part of the Moulineaux plant is the main building which contains the dynamo and boiler rooms. It measures 370 feet long and 130 feet wide. The side next the river contains the machinery, while the sea part contains the boilers and coal supply. The station develops a normal output of 7500 kilowatts, but has a considerable reserve power which will come into use with the further development of electric traction.

The boiler house contains nine batteries of three boilers each and has especially good facilities for handling coal as well as for disposing of the ashes and cinders. The nine batteries of boilers are arranged in a single row, which extends the whole length of the building, as Fig. 2 shows. To the right will be observed the disposition of the coal supply. The coal is fed into a row of bunkers which lie parallel to the grate fronts. Some repairs were being made here at the time of taking the photograph, which accounts for the apparent disorder. The boilers were built by the Meunier Company, of Lille. They are of the type known as "semi-tubular," which is used considerably in France. This type of boiler is preferred where the load is extremely variable.

The coal is usually brought to the station on railroad cars, and a track has been laid alongside the boiler room so that the coal can be dumped directly from the cars into the bunkers. When coal is delivered from barges on the Seine, it is unloaded on the wharf and a small industrial railway brings it to the bunkers. The cinders are handled very conveniently by means of small cars which travel along under the boilers on a track laid in a tunnel. The cinders fall from the grate into a pit which has a gate opening into the side of the tunnel, so that the cinders can be dumped directly into the cars. The latter are then run out to the forward end of the tunnel, where the cars dump into a pit; a motor-driven conveyor takes the cinders from the pit and elevates them over the railroad cars, into which they are finally delivered.

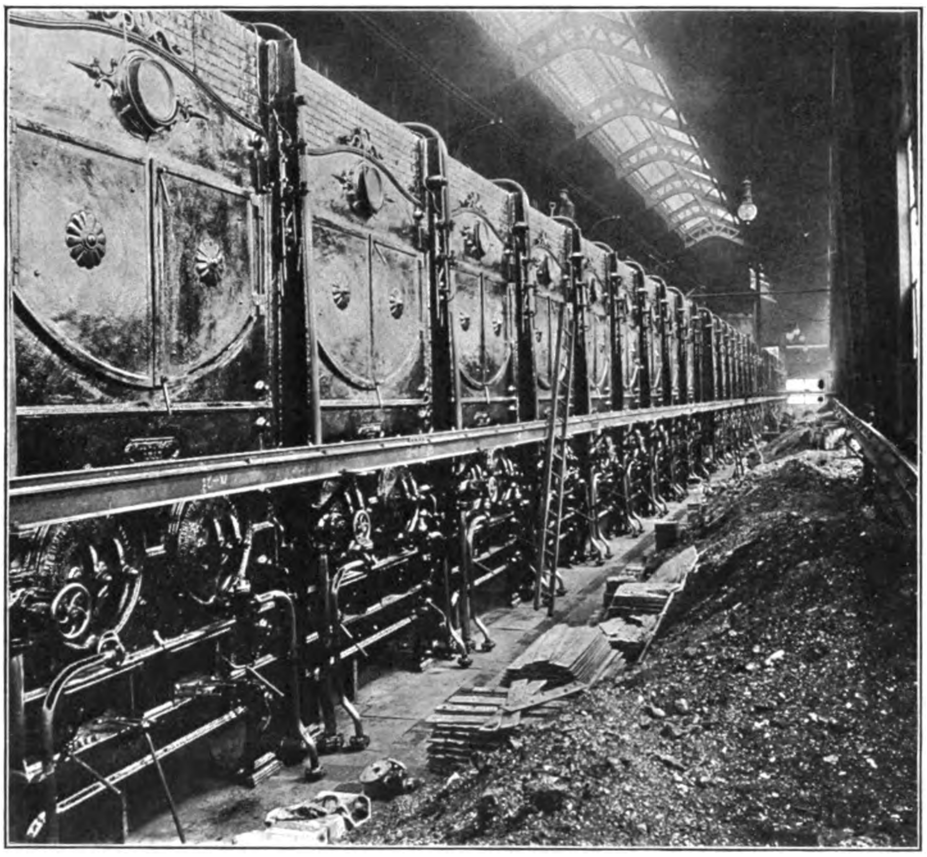
FIG. 2.—BOILER ROOM OF MOULINEAUX POWER STATION.

The boilers use the water coming from the condensers. It is taken at the outlet of the condensers by pumps which are operated from the main engine. Two small Worthington pumps in the boiler room are used as a reserve, and these take water directly from the main reservoir of the station. The excess of condenser water is sent into the overflow main by a discharge valve. The cooling water for the condensers is taken from the Seine by six centrifugal pumps, which are direct-driven by electric motors of 50 horse-power and are located in a separate building. The water is elevated from the river to the main reservoir, which has a capacity of about 80,000 U. S. gallons. A system of piping, partly of beton conduit and partly of iron pipe, carries the water from the reservoirs to the condensers. A second conduit lying below the former returns the condenser water to the Seine.

The products of combustion of the furnaces pass into an underground tunnel which is connected to three chimneys, one located near the middle of the boiler room, and the others outside at either end of the building. The chimneys are 160 feet high and 10 feet in diameter at the base.

The main steam piping passes along above the boilers, and each of the latter is connected to it by a valve. From the main pipe a branch pipe leads to each engine, passing behind the boilers and then descending into the basement under the main dynamo room, which contains all the piping for the engines.

The spacious room which contains the generating units is one of the largest dynamo rooms in France. The front page engraving shows a general view of this part of the station, in which the arrangement of the generating units, which are similar in character, will be observed. This room is 370 feet long and 65 feet wide, and is well lighted on the side next the Seine by a series of large windows. It contains the main alternators, the exciter groups, and a switchboard of eighteen panels. The latter is mounted in a gallery at one end of the station. There are nine alternating-current three-phase generators direct-coupled to horizontal steam engines, arranged in a single row along the length of the building. Spaces are left between the third and fourth machines and between the sixth and seventh in which are located the exciter groups with upright engines, of which there are four in all.

The alternators are of the Westinghouse type and of uniform construction. Each unit is designed to give 800 kilowatts on average running, or 1100 kilowatts maximum. Six of the alternators are driven by engines which have been furnished by the Dujardin Company, of Lille. The engines of the three remaining groups have been supplied by Garnier and Faure Beaulieu, of Paris. The four exciter groups are direct-coupled to Westinghouse engines of the well-known upright pattern. The main dynamo hall is equipped with two large electric traveling cranes of 20 tons each.

Under the dynamo room is a basement which runs for the whole length and contains the steam and water piping for the engines, as well as a part of the condensers and pumps. As the basement lies below the high-water level of the Seine, it had to be specially constructed so as to make it water tight. The whole surface of the floor is constructed of armored beton about three feet thick, upon which rest the foundations of the engines and dynamos.

Besides the main building, devoted to the machines and the boilers, the plant contains various buildings, for the different purposes of the station, including repair shops, storerooms, pump house and reservoir, offices and testing room.

The Dujardin engines which form part of the first six groups (in the background of the figure) are of the triple-expansion type with four cylinders. They have two cylinders in tandem on each side of the alternator. These engines operate at 80 revolutions per minute. The diameter of the high-pressure cylinder is 26 inches; the intermediate and low-pressure cylinders measure 44 inches; the stroke is 54 inches. The governor acts upon the high-pressure valve-gear, but for the other cylinders the steam admission is constant. These engines are of the condensing type and the condensers (of which there are two for each engine) are located in the basement directly below the cylinders. If need be, the engines can be made non-condensing by means of a valve in the exhaust piping, in the usual way. The engines drive the air-pumps of each condenser and also the feed-pumps which are connected with the main water conduit. While the normal power of the Dujardin engines is 1350 indicated horse-power, they can be run as high as 1700 horse-power, as has been shown in the tests. The cut-off is fixed in the case of the intermediate and low-pressure cylinders, and these work at 35 and 50 per cent respectively. For the high-pressure cylinder, the cut-off is variable and is controlled by the governor so as to work between the limits of 26 per cent for a load of 800 kilowatts and 40 per cent for 1100 kilowatts, which is as high as they are expected to run.

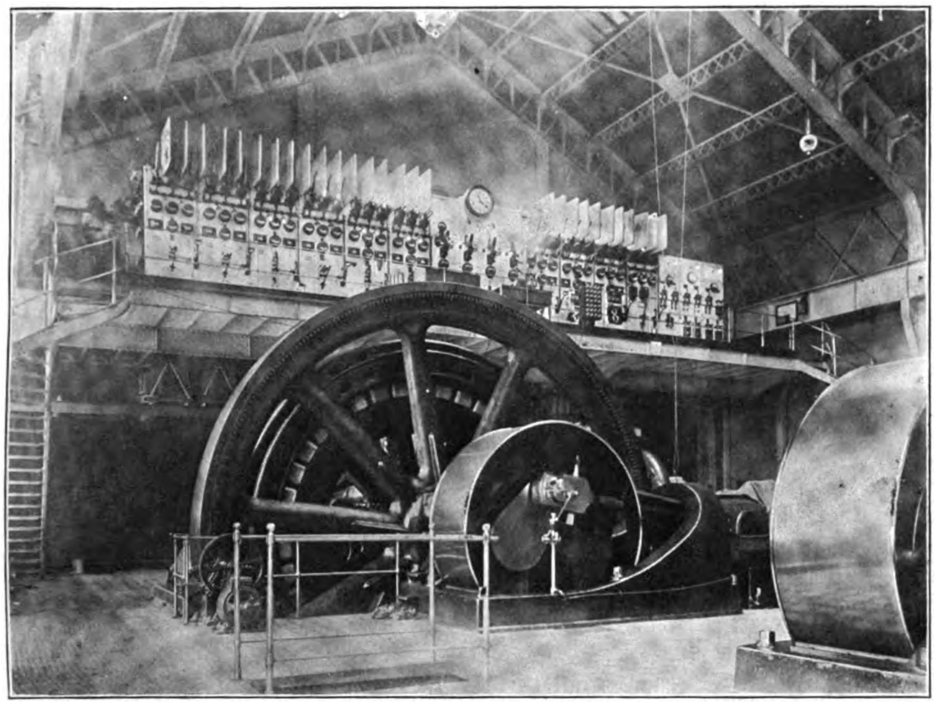
FIG. 3.—VIEW SHOWING SWITCHBOARD GALLERY.

As the inertia of the alternator is insufficient for the proper running of the engine at varying loads, a heavy fly-wheel has been added to each unit. It is placed on the side of the intermediate cylinder, while the alternator is mounted between the fly-wheel and the high-pressure cylinder. The fly-wheel measures 24 feet in diameter and weighs 22 tons. The cylinders of the engines are provided with steam jackets. Steam at boiler pressure passes through the high-pressure cylinder jacket before it enters the cylinder. For the other cylinders, the steam pressure is lowered to 75 pounds. The Dujardin engines are provided with automatic oiling apparatus. After passing through the engine the oil is collected in a reservoir and then goes through a filter. The oil is made to circulate by means of small pumps which are operated from the engines.

The Garnier and Faure Beaulier engines which are used with the last three alternators (noticed in the foreground) are of the Corliss cross-compound type, with cranks placed at 90 degrees. The normal steam pressure at the throttle is 130 pounds per square inch. The high-pressure cylinder is 30 inches in diameter and the low-pressure 55 inches, with a common stroke of 52 inches. The engines operate at 80 revolutions per minute. The admission of steam is variable in both cylinders, the governor controlling both valve-gears at the same time. The cut-off for the normal load of 800 kilowatts is 20 per cent for the high-pressure cylinder and 35 for the low-pressure. In the case of the high-pressure cylinder the admission valves are situated at the upper part, while the exhaust valves are placed below. Like the preceding engines, arrangements are made for allowing them to exhaust at atmospheric pressure, but ordinarily condensers are used. The latter are placed on the main floor and are located back of the cylinders, as will be observed. The air-pump of the condenser is operated by a prolongation of the piston-rod. The feed-pumps and other apparatus for the condensers are located underneath the engines in the basement. The cylinders are steam-jacketed. A heavy fly-wheel, 23 feet in diameter and weighing 25 tons, is mounted on the alternator shaft. Each of the groups in the dynamo room is provided with a small three-phase motor for "turning over." The motor operates a pinion which engages with the teeth which the fly-wheel carries on the periphery.

The four upright exciter units are set in pairs in the two spaces left between the alternator sets. Fig. 4 shows two of the groups. The generators are driven by high-speed Westinghouse compound engines and are mounted on the same bed-plate. The engines take a steam pressure of 130 pounds at the inlet. The high-pressure cylinders have a diameter of 13 inches and the low-pressure, 22 inches; the stroke is 13 inches and the speed 290 revolutions per minute. Each engine has an individual condenser. The exciters, which are of the standard Westinghouse pattern, are 120-volt machines, with eight poles of laminated iron. The main exciter circuits pass under the floor to the switchboard. The current is used for exciting the fields of the alternators, of course, and also for lighting the different buildings of the station. Part of the current is also used by the motors which drive the different pumps situated on the premises, as well as for a number of motors in the repair shops and testing room.

The nine alternators of the Moulineaux station are of identical construction. These machines have been erected by the Westinghouse Electric Company and the present plant was one of the first large stations to be equipped by that company in France. The alternators are designed to give three-phase currents at 5000 volts and a frequency

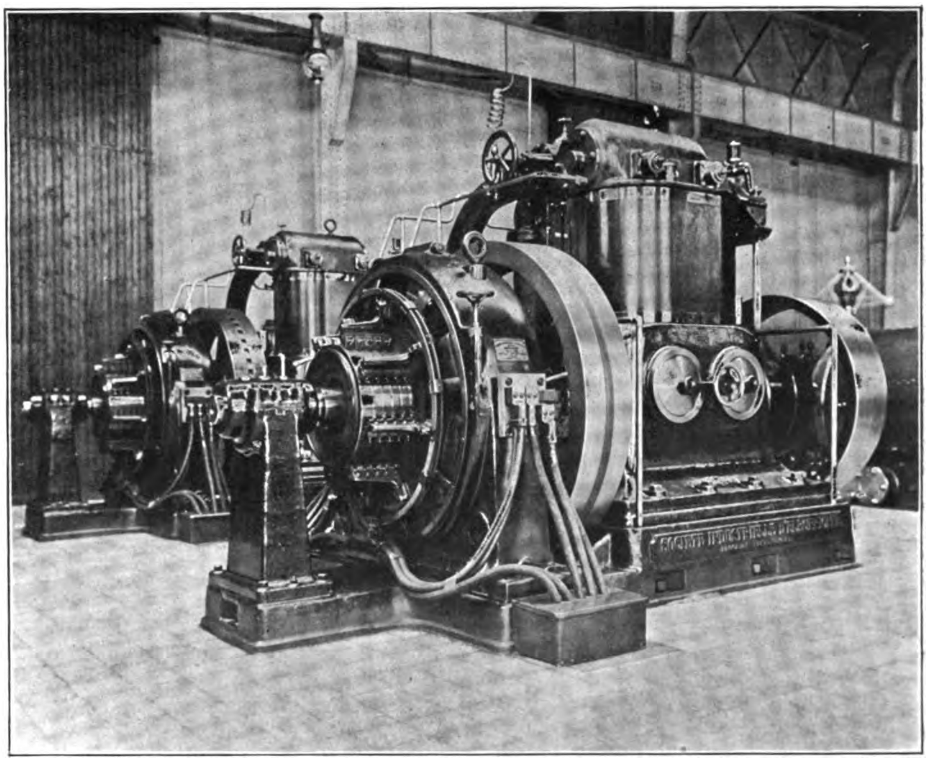
FIG. 4.—STEAM-DRIVEN EXCITER UNITS.

of 25 cycles. The revolving field-magnet is of the usual laminated construction, mounted on a central fly-wheel. It has a series of openings for cooling, which correspond with a similar set of holes in the outer armature ring of the machine. The diameter of the revolving part of the alternators is 14 ft. 2 ins. The central fly-wheel is formed of two parts which are bolted together.

The field winding consists of flat copper strips and each pole contains 49 turns. All the field coils are connected in series and the exciting current is brought by copper brushes from a pair of collector rings. The fields of these alternators are excited at 110 volts. The current which is required varies from 175 amperes at no load to 195 at full load.

The armature is wound for 5000 volts, no step-up transformers being used; it is connected star fashion. The core contains three slots per pole per phase, or nine per pole. The slots, which measure 14 x 40 millimeters, contain four well-insulated conductors each. The total length of armature iron measured along the axis is 572 millimeters, which includes the ventilating spaces. The internal diameter is 4.674 meters across the laminated part. The weight of the external housing is about 40 tons. It is arranged so as to slide back and forth for inspection or repairs.

As to the consumption of coal in the station, it may be remarked that the tests which were made at the beginning showed a consumption at full load equal to 2.2 pounds of coal per kilowatt-hour measured at the mains leaving the station. This figure includes all the different auxiliary apparatus needed for operating a group, such as exciters, pumps, etc. The consumption proved about the same for both types of engines.

One of the engravings shows the large switchboard which has been installed at one end of the station. The main part of the switchboard is located on an elevated platform which is reached by an iron staircase at either end. The switchboard is built of white marble panels mounted on an iron frame. There are generator panels (one for each machine), four exciter panels and five panels for the feeders. An automatic circuit-breaker of long stroke is used for each machine; it has the usual copper and carbon break, and is shielded by a projecting panel on each side.

Each of the alternator panels contains three ammeters (one for each phase) and two wattmeters which give the total power of the machine by adding their readings. The alternator panel is completed by the usual apparatus for controlling the field current, including a rheostat, ammeter and switch. The latter is arranged so that it cannot be operated except when the alternator circuit is properly connected. To synchronize the alternators for coupling in parallel, a phase lamp is used which is enclosed in a dark box. Synchronism is shown by the extinction of the lamp. The switchboard is provided with a main voltmeter and "total output" ammeter. The voltmeter is connected by a commutator with the secondaries of the synchronizing transformers. The exciter panels are of the usual character. A common voltmeter is used with all four machines and is connected in by a plug and flexible cable. Each exciter panel carries an automatic circuit-breaker, switch, ammeter and rheostat. The feeder panels carry each a circuit-breaker, three ammeters and a wattmeter.

The current is brought from the machines to the main switchboard by a set of cables which pass in conduits under the floor of the station and then rise to the gallery back of the switchboard. From the main switchboard, the high-tension current is carried to a second switchboard placed below the former and on a level with the first floor. It serves as the starting point for the feeders which leave the station and contains the necessary meters for taking the readings of each distribution circuit. The high-tension feeders leave the station underground. The cables which supply the Invalides-Versailles electric road are of the Berthoud-Bonel three-conductor type and are laid along the tracks as far as the terminal of the Champ de Mars. The electric road is supplied at 500 volts by several sub-stations.

The Moulineaux station has been running very successfully ever since the outset, and the demand for current is constantly increasing. It is under the supervision of the director, M. Tainturier, a well-known engineer of Paris.

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NOTES ON INTERHEATING RECEIVERS FOR COMPOUND ENGINES.

The efficiency of interheating receivers for compound engines as a means of reducing the net steam consumption has often been discussed by engineering writers but without any general agreement as to whether or not the saving in fuel obtained by their use was worth the added cost and complication. The majority of engine builders seem to have concluded that, as it is a case where the doctors disagree, the sharpness of competition renders it inadvisable to include interheating receivers in their specifications unless called for by the purchaser. On the other hand, such a large proportion of the best economy records for both steam engines and steam pumping machinery has been obtained with interheating receivers that the cases where indifferent results have been secured are apparently due to the lack of a clear understanding on the part of some of the makers of such apparatus of just what an interheating receiver should be expected to accomplish.

The sole object of an interheating receiver should be to superheat efficiently the steam entering the low-pressure cylinder, by a transfer of heat from steam at boiler pressure (which by reason of its higher temperature is suitable for this purpose), to the steam exhausted from the high-pressure cylinder. The gain in economy is precisely of the same nature as that obtained by supplying superheated steam to the high-pressure cylinder. It is generally conceded that the saving from a moderate degree of superheat, such as will prevent internal cylinder condensation, say up to a superheat of 100° F., is much greater proportionately than the added gain from carrying the degree of superheat materially higher, not to mention certain decided disadvantages which accompany a high degree of superheat. It follows, therefore, that the interheating receiver will give the considerable advantages of a moderate superheat for the low-pressure cylinder in any station, and in power stations where a superheated steam supply is available, the full saving to be commercially gained from the use of superheated steam can be effected without the necessity of a high degree of superheat in the steam supplied to the high-pressure cylinder. A properly constructed interheating receiver involves no additional complication or attendance other than means for returning to the boiler the condensation in the heater coils. This can be accomplished by the high-pressure drip return system, which should be provided in every well-designed station to return the water of condensation from the high-pressure piping and separators.

Since the heat required to evaporate a pound of water at the usual receiver pressure is nearly twenty times that required to superheat a pound of saturated steam at that pressure up to 100° F., it follows that if the heating coils in an interheating receiver were called upon to dry out steam received from the high-pressure cylinder containing five per cent of moisture, the entire superheating effect of the heating coils would be lost if the rate of transfer of heat per square foot of heating surface remained the same. This effect is lessened somewhat, though not materially, by a slightly higher rate of heat transfer due to the moisture in the receiver steam. From this it is evident that the receiver should be so arranged that water in the steam exhausted from the high-pressure cylinder is trapped away and not re-evaporated by the superheating coils; inattention to this point is a probable cause of failure in many interheating receivers. Any evaporation of water in the receiver steam is analogous to running a single cylinder engine with steam at an initial pressure of from 10 to 15 pounds above the atmosphere and generated in the indirect manner described.

A very considerable amount of heating surface efficiently arranged is essential to the success of any interheating receiver. The rate of transfer of heat from steam at boiler pressure to steam at receiver pressure is less per square foot of heating surface than in a boiler with water on one side of the tubes. This makes it necessary to use a large receiver well filled with heating coils and so arranged as to secure circulation and avoid dead ends. Any interheating receiver provided with merely a jacket for heating the receiver steam is worthless. In short, unless an interheating receiver actually superheats the receiver steam as described, it is a disadvantage.

One prominent engine building firm who always provide interheating receivers of large capacity filled with seamless brass or copper heating coils, report quite a uniform rate of heat transfer per square foot of heating surface, as the results of over twenty acceptance tests made by purchasers. In the cases where tests were made on the same engines with and without interheating receivers in use, and with from 50° F. to 100° F. superheat in the steam entering the low-pressure cylinder, a net saving in the rate of steam combustion of from 5% to 10% was obtained with saturated steam supply. In stations where superheated steam is supplied to the high-pressure cylinder, the corresponding saving is from 3½ per cent to 5 per cent. For engines of longer stroke or those from any cause more efficient, considered as heat engines, the saving is less than with less efficient engines. Also the saving at light loads is more than at full load, as might be expected, and has the effect of flattening the curve of steam consumption at light loads. The percentages of saving just mentioned refer only to the steam supplied to the engines. Under regular operating conditions, when the hot water of condensation in the heating coils is returned to the boilers there is an additional saving in the rate of heat units per minute supplied to the feed water per indicated horse-power developed in the engine, and, therefore, in the coal burned per indicated horse-power; this amounts to from one per cent to two per cent.

THE MECHANICAL STOKER AND THE HUMAN OPERATOR.

BY EDWIN YAWGER.

Much of the literature on stokers and on combustion in general consists of records of various performances, in which, as a rule, some one feature is prominent and others more or less ignored. A vast majority of boiler trials are utterly unreliable, and even the most reliable contribute little assistance to commercial judgment. Mr. Bryan Donkin, in his book "Heat Efficiency of Steam Boilers," gives a careful analysis of 425 boiler trials. His conclusion from this array of data is best given in his own words:

"When making these summaries, the author at first thought he might be able to draw from them the conclusion that some one type would prove to be more economical than another. It is quite clear that much depends upon how a given boiler, of whatever type, is worked, with clean or dirty surfaces, good or bad combustion, etc., than upon its form, internal or external fires, water or smoke tubes, or the particular way the differently shaped heating surfaces are presented to the furnace and hot gases."

When 400 trials, carefully selected and analyzed, fail to produce any general law, it is evident that another point of view is necessary for broad practical conclusions. Leaving out, then, the question of detailed tests, it will be the object of this paper to present some of the general considerations that bear on the art of combustion of fuel in boiler furnaces.

The mechanical stoker, as a machine, must possess many points of excellence in order to contribute fully to net commercial economy. First and foremost, it must be so designed that it will continue to supply heat to the boilers in spite of accidents or unfavorable conditions of fuel and service. If heavy clinkers form they should be capable of easy disposal. If the actuating mechanism fails, it should be possible to continue firing by hand manipulation. If grates break it should be possible to replace them without drawing the fire. In addition to these primary requirements are numerous details that must be worked out in all their relations before the full measure of fuel and labor economy can be realized.

I believe that next to the matter of continuous operation, the most important feature of furnace design lies in the control of the air for combustion. A noticeable thing about records of boiler trials is the general lack of uniformity of results under apparently similar conditions. Unfortunately, the factor that enters most largely into this variation is seldom recorded, namely, the relative amount of air consumed. In furnace combustion the fact is often ignored that air is a fluid with a definite specific gravity and a consequent inertia.

No one would expect water mains to be efficient if constructed with diversified cross sections, sharp turns, and odd corners. Yet it is common to build furnaces in which the gases meet with improper deflection, unnecessary obstruction and restricted passages. Sometimes the ash-pit and its doors are arranged in such manner that the air by its inertia seeks passage through a restricted area of the fire, usually the rear. I have in mind one case where a hopper-bottom ash-pit being open at the front furnished the principal channel for incoming air, which was directed against the rear of the fire, thus causing air-holes and a reduction in capacity and efficiency. In some cases a great loss in draft efficiency is caused by the clashing of burnt gases as they issue from various boilers into the smoke connection. I know of a case where two boilers were fitted with a vertical uptake extending over both boilers. An increase of 25 per cent in the efficiency of the draft was accomplished by placing a partition in the uptake, to separate the gases issuing from adjoining boilers. It is a matter of common observation that there is frequently a considerable variation in draft in different furnaces where a number are connected to the same stack.

When the furnace is hand-fired, all the losses due to the improper manipulation of the air supply are rendered much greater. An indication of this can be obtained by noting by means of a gauge the variation of draft in the fire chamber during a cycle of firing.

I believe it is the practice of boiler manufacturers to establish a fixed arrangement of baffles. The furnace specialist goes further than this, and arranges the baffles to conform to the nature of the service, and the amount of draft in the particular case.

Accessibility is a prime requisite, and that stoker will give the best service in which the condition of the fire can be seen and obstructing clinkers dislodged without the opening of doors.

In view of the prevailing tendency toward the use of large boilers, stoker design must permit of a corresponding expansion of grate surface. In many cases 500-h.p. or 600-h.p. boilers, instead of being fitted with the proper amount of grate area as determined by the draft and weight of coal to be burned, are expected to give results on a restricted grate, simply because the design does not permit the proper area.

The data at hand on the question of durability offer, if possible, a wider range than above indicated for boiler trials in general. The peculiar thing about reports of stoker repairs is that the records cover only the two extremes of experience. In a few plants the small cost of repairs being a matter of pride, a segregated record is kept of stoker repairs. In other plants, more unfortunate in design and operation, excessive repairs are often reported. The range in this respect varies from half a cent or less per ton fired, to 12 cents in extraordinary cases. In the large majority of plants between these extremes there is no record available.

It should be noted that the life of a boiler and a furnace should be logically reckoned not by the year but by the gallons of water evaporated and the number of tons of coal burned.

Other questions of furnace design no doubt have two sides, with advocates for each. A number of makers construct furnaces calculated to reject the refuse continuously and automatically, the argument being that this reduces the labor required and adds to the effectiveness of the operation. On the other hand, it is claimed that continuous discharge will carry over a considerable amount of combustible when fires are forced, while with light firing there will be a thin zone in the fire near the discharge point that will admit an excess of air; also that large clinkers will occasionally fail to pass through an otherwise automatic discharge.

The extent of the fire-brick arch over the fire in furnaces operating with progressive feed is sometimes subject to discussion. The presence of an arch sufficient to reflect heat on the fuel until it is well coked is always recommended. It is argued, however, that the external fire chamber, with its full-length arch, throws back all of the radiant heat upon the fire, thereby increasing the rapidity of combustion and insuring its completeness. Other authorities state that it is better to expose the heating surface promptly to the highest possible temperature, to this end making use of a large proportion of direct radiation. Rankine states that about one-half of the total heat from the combustion of coal is given up in radiation. The open fire, therefore, would project a greater quantity of heat against the first row of tubes, with a tendency to intensify evaporation at that point. Experiments made by the Northern Railway Company of France showed that evaporation around the fire-box of a locomotive boiler averaged seven times as great per square foot of heating surface as the rate in the flues.

There is no increased danger to boiler tubes by reason of high temperatures. The rupture of a tube in invariably due to some cause within itself, either a flaw in material or the presence of scale sufficient to interfere with the releasing of steam. With these facts in mind, and with a view to reduce as far as possible the loss by external radiation and air leakage, it seems the logical thing to design an arch deep enough to insure the absence of combustible gases in the flues, at the same time permitting a liberal amount of direct radiation.

Judging from the number of 60-foot stacks in use, especially in steel works, there would appear to be a wide difference of opinion on the subject of draft. If I were asked to specify a single improvement in furnaces that would net a greater saving than any other, the reply would be "double the height of all the stacks now in use." Intensified draft will work wonders. First, it will permit the burning of more coal per square foot of grate, thereby increasing furnace temperature. The burning of more fuel per square foot of grate surface, and the consequent high temperature, is in itself an element of economy, illustrating one of the fundamental laws of thermodynamics, which states that efficiency is dependent on the range of temperature in the working medium. Second, it will make combustion complete at a point nearer the coal; that is, the flame will be shorter, and the excess of air will be less. This condition is due to the fact that a strong draft rushes among the fuel at high velocity, causing a more intimate mixture of air with the inflammable gases. Third, the same volume of gas at the same temperature will give up more of its heat when passed rapidly than when passed slowly over the same heating area. Many experiments have been made to determine a law governing the effect of speed on the liberation of heat from gases, but the results are variable. All agree, however, that the effect is important.

It is plain from this that the stack or draft apparatus has a function not usually accorded to it; namely, that of overcoming friction in gas passages induced by high speed of gases, the result will be a reduced capacity and a higher stack temperature.

Lack of space forbids taking up other points that are quite well known but often overlooked. For instance, that soot is more fatal to economy than is scale, but not so fatal to boilers, and that under no circumstances does water do duty as fuel.

It is common experience that no part of a power plant is subject to so much neglect as are the boilers. The reason for this lies in two inevitable weaknesses of human nature, namely, a reluctance to perform a dirty and disagreeable task, and a reluctance to perform any task when its results are not apparent to the observation.

An engine operator may build up a reputation by giving such attention to his engines that they will not offend the eye or the ear of the observer. The chances are that if his engine looks clean and runs quietly, it is in fact in good order; but the external cleanliness of a boiler would argue little as to the absence of scaled tubes, soot-choked passages or broken-down baffles.

Some years ago I became partly responsible for the operation of a large mechanically fired plant in Pittsburg. There were 16 boilers in the plant, and I was asked to determine why it seemed impossible to secure sufficient steam for the engines. I made a brief examination of the boilers, and found that the stack draft in the different batteries ranged from 0.45 inch to 0.7 inch of water, and that stack temperatures varied from 450 degrees to above 700 degrees. The general condition inside the furnaces seemed obvious. I agreed with the management to pick out a man who would enter their employ and have full charge of the boiler plant, with the expectation that a change would soon be apparent. An inspection by this man showed that in some cases soot had accumulated in such quantities as to choke the gas passages. This explained the low draft and temperature in some of the stacks. In other cases the baffles were broken down and displaced to such an extent that the gases made practically one pass through the tubes and escaped at high temperature. This gave the key to the other extreme stack condition. It was found, by a little close observation, that the attendants reported the external cleaning of the tubes without going through the formality of doing the work. A short period of personal supervision served to put the plant in such condition that steam was easily supplied by 14 boilers instead of 16. This happened in a stoker-fired plant; it would have been worse in a hand-fired one, because the same human nature would have been there, only more of it. It is evident that such delinquencies on the part of attendants work equally disastrous results, whether the plant is stoked by hand or by machine.

There is another phase of human nature that has an important bearing on the comparison of hand and machine firing which probably furnishes the stoker manufacturer with his strongest argument in favor of the superior fuel economy of the mechanical stoker. It is the well-known fact that there is a wide variation in the efficiency of individual firemen in the actual manipulation of the fires. During the World's Fair I was called upon by the judges to conduct some comparative economy tests on traction engines, for the purpose of determining the fuel economy of boilers and engines combined, when running at constant load, the furnaces being fired by the manufacturers' expert firemen. In five engines tested there was a variation in results of about 15 per cent. The steam distribution and the furnace and boiler design were quite similar in all five engines, and it would be safe to assume that their inherent efficiencies would not vary more than 5 per cent. The further difference, therefore, of 10 per cent should be charged to the variation between expert firemen.

One universal result of the substitution of mechanical for manual methods consists in a greater uniformity of product, and from the nature of the operation it is possible to maintain a stoker at or near its highest efficiency. To obtain this very desirable condition it will be necessary to start right by making a competent engineer responsible, not only for the selection of the machine, but for the unity of design of the entire furnace, from ash-pit to top of chimney. The responsibility is often assumed by stoker builders, and some of them refuse to make an installation unless full and satisfactory information is furnished covering all the essentials of the furnace.

To maintain a boiler plant at its highest efficiency is not a complex problem, but it requires constant and intelligent supervision. It is its capability of responding to intelligent supervision that renders mechanical stoking superior to the human kind. The functions of the machine are varied, when necessary, by positive adjustments, and changes in adjustments can be governed by definite rules easily within the comprehension of the dullest operator. I should say in general that any chief engineer of a station, who himself is capable of operating successfully a mechanical furnace, can, with a reasonable amount of attention, secure uniformly good results throughout a large plant.

A daily inspection of the fires will assist as much as anything, remembering that a white-hot fire in an indication of all-around economy.

Recording instruments of various kinds will be found useful, especially in mechanically fired plants. Probably the most useful record obtainable in connection with furnace operation is a record of the amount of air supplied. With the uniform conditions due to mechanical stoking, such a record gives a fair indication of the degree of efficiency of the furnace. This record is obtained in many plants by an apparatus for the continuous analysis of flue gases. The use of a draft gauge, attached permanently and showing the draft in the fire chamber, will give an approximate idea of the amount of air consumed. A diminution in draft at this point indicates air holes and an excess of air, while a great increase will indicate too great a thickness of fire and the probable presence of carbon monoxide in the flue.

An expert stoker fireman, in running a test, will keep his fire gauge at that point which indicates the proper thickness of fire.

Many reports find their way into print condemning wholesale the use of stokers, and there are circulated many reports of expensive installations being placed on the scrap pile. It is just possible that in some of these latter cases the mistakes occurred not in the purchase but in discarding the stokers without making sure that a correction in some other part of the system would not have removed the difficulty. Misfit installations are fortunately decreasing in number, and there are now millions of horse-power of boilers machine-fired in the United States.

[The foregoing is an abstract of a paper read before the Boston convention of the National Electric Light Association.]

THE COST OF WATER AND ELECTRIC POWER.

BY GEORGE E. WALSH.

The relative cost of power for electrical purposes differs so widely in various parts of this country and Europe that a study of records of different important plants has in recent years become an essential factor in an engineer's equipment for his work. Factory and mill economy of every description primarily comes back to the first step of generating power. Fuel, labor, water, oil and repairs are all a part of this question. The cost of power must differ because of the difference in the cost of fuel and of water rights, but gradually through comparison of data and methods employed in different parts of the world a standard of cost is being reached. Until close attention was paid to the work of systematically keeping steam, water and general station records, it was impossible to eliminate many of the factors of loss and waste. By locating the cause of waste it has been possible to lessen the losses, and the economy of operation thereby effected has been of far-reaching importance.

As the leading country of the world in the development and utilization of water power for electrical purposes, the United States should stand at the head in the matter of economical production of horse-power for factory or mill purposes. We have some million and a half horse-power developed from water in this country against France's half a million and Norway's quarter of a million. But even these great totals represent only a small fraction of the water power that might be developed in any of the countries through the utilization of water courses. The aggregate power of our own streams is so great that it is impossible to forecast their ultimate improvement. In Africa, South America, India and Canada there are likewise immense water courses that can be utilized for electrical purposes that will make the present development of Niagara appear small in comparison.

A study of the cost of water power in France indicates that the variation is extreme, more so than in almost any other country. This is partly due to the physical conditions of the country, and partly to the methods employed. Experiments with new forms of turbines, water wheels and generators are constantly being carried on there, and to include the results obtained from them in the records brings the cost of power up to high figures. Thus the official cost of a water power plant in France is estimated to vary from $21.40 to $150 per horse-power. When the first turbines were installed at Geneva the effective horse-power cost $300; but when the rest of the plant was finished, and the new units improved, the cost was reduced to $95 per horse-power. Notwithstanding this, the average cost of the plant is estimated at $135 per horse-power.

Consideration of other French plants will show that the cost of water power in that country is, on the average, excessively high from an American point of view. At Vonvray on the Rhine, water power was developed and sold at a total cost of $160 per horse-power for the first 2000 horse-power, and $55 for the second 2000 horse-power. This big reduction indicates that the installation of large units is an important factor in the ultimate cost of delivery of power. A small plant is thus hardly of any value for comparison with a large one.

All through France and Europe the charges for water or electrical power differ widely; but this is not always a sure sign that the cost of generating the power is so much greater in one place than another. The exorbitant charges in some French cities for power are well known, and some towns have driven from their precincts plants that depended upon cheap electrical power for their operation. To show what can be accomplished through the improvement of plants under modern conditions, the cost of development of 3000 horse-power at Vallorbe amounted, according to the capital expended, to only $19.45. On the other hand, the yearly rental of power at Lyons is $90 per horse-power, while in one plant in the same city the highest capital expenditure amounted to $420 per horse-power developed.

In Switzerland the cost of water power is relatively smaller than in France. The physical conditions of the country are the chief reasons for this. The streams and waterfalls of Switzerland furnish an abundance of power for large development, and the engineering schemes that have utilized some of these mountain water courses have been up-to-date in every respect. While the average for the country is placed at $30 per horse-power per year, there are numerous plants that furnish it as low as $20.

In Germany and England the cost varies almost as greatly as in France; but there are effective plants that are prepared to furnish power from $21 to $45 per horse-power per year. The charges for power in some of the factory districts of England are remarkably low considering the engineering difficulties and heavy expenditures of capital to secure effective results. Germany has made more progress than any other nation in using the best machinery and turbines to overcome natural physical disadvantages of the country.

In this country power from hydraulic plants is delivered cheaper than anywhere else in the world. At Columbus, Ga., in the great cotton mill district, electrical power is delivered at the secondaries of the consumers' transformers at the low rate of $15 per horse-power per year. Moreover, the transformers are furnished by the power company, so that the expense of their installation is not included in the consumers' capital expenditure. Power at this rate is supplied to consumers using 1000 horse-power or over, and the contract allows it to be used sixty-six hours per week.

To Niagara one turns naturally to secure data for comparison with other parts of the country. The charge for electrical energy there differs a good deal according to the amount used. The chief object of the Niagara development was to furnish current in large quantities and at little cost; the small consumer is consequently at a disadvantage there. The large consumer finds charges scaled according to his needs, and in such a way that no other region of the world is so well suited to his work; he can secure current at much less than half the rate to the small user. Thus a plant using 1000 kilowatt-hours per month or less is charged two cents per kilowatt-hour, while the consumer of 80,000 to 200,000 kilowatt-hours receives his power at the nominal charge of 0.64 of a cent per kilowatt-hour.

The development of water power along the line of the Canadian border has also been carried out with the idea of encouraging the establishing of groups of large manufacturing plants dependent upon electricity for their operation. The remarkable success of the Niagara people in building up new industrial centers, and in establishing entirely new groups of industries through the cheapening of electrical current for plant operation has naturally stimulated other capitalists to develop streams and falls that offered favorable conditions. At Massena the installation of large electrical units has produced a duplicate of Niagara's history. Already power is supplied there to dozens of plants at a cost not much different from that charged by the Niagara station.

At Kakabeka Falls, twenty miles above the town of Fort William, Ont., where the river by the same name plunges over a precipice 125 feet high, a company is now constructing a plant which will supply electrical power on a small scale at $18 per horse-power per year. A contract has been made with the town of Fort William, and the company evidently sees its way clear to making a profit on the power furnished at the low charge mentioned.

So far the cotton mills of the South have probably been most favored of any plants outside of the Niagara and Massena districts in obtaining cheap electrical power for operation. The use of the electrical current there is consequently increasing steadily. This is one reason for the wonderful prosperity of the southern mills in recent years, and the New England mills that have had to compete with them are gradually adopting electricity for the same purpose. The loss through the drying up of streams for several months each summer is enormous in New England. By systems of storage reservoirs on the streams near their source, so that power can be transmitted electrically to groups of cotton mills as it is needed, this annual summer loss through closing down or generating power by steam can be eliminated from the problem. At present the average cost of horse-power per year for the New England cotton mills is two or three times as great as the rates at which the Southern mills obtain their power direct from electrical power plants. Even with coal and other fuel at the lowest market rates, the summer cost of generating power is so great that the average for the year is increased considerably.

BOSTON CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION

The twenty-seventh convention of the National Electric Light Association was held at the Hotel Vendome, Boston, Mass., May 24, 25, 26 and 27. At the opening, about 400 delegates were in attendance in the hall. President Charles L. Edgar delivered an able address which was listened to most intently by one of the largest gatherings that ever witnessed the opening exercises of a convention. He referred to the fact that he had been one of the attendants at the former convention in 1887, as the guest of Capt. Brophy, when he visited the old Thomson-Houston works at Lynn, Mass., when the entire number of men employed was not equal to the number now in any one of a dozen departments. At that time the Boston Edison Company was the possessor of one small station, with a total load connected to its overhead system equal to the fortnightly growth of the present year. Referring to the general growth of the central station business, as represented by the members of the association distributed throughout the United States and Canada, he found that the number of electric light stations has increased during these seventeen years more than nine fold.

Mr. Edgar recommended, in view of the fact that a large number of small central stations have been displaced by a smaller number of large stations, that the by-laws of the association be amended so as to add another class of membership, consisting of individuals to be known as junior active members. He also recommended that the association establish permanent headquarters in the Union Engineering building when that is completed.

The report of the Committee on Progress was presented by Mr. T. C. Martin, chairman, and contained some very interesting statistics. It showed that in 1902 the aggregate station capacity of the United States was 1,205,148 kilowatts for the lighting plants, and 898,362 kilowatts for the railway power houses. The advancement in the construction of electrical apparatus was also pointed out, and the new types of apparatus recently developed mentioned. Following the presentation of Mr. Martin's report, a paper on

A Three-Wire, 500-Volt Lighting System

was read by Mr. Walter I. Barnes. This paper is abstracted very fully on another page. The discussion of the paper by Mr. Barnes was quite extensive, covering principally the subjects of grounded distribution and the twin arc lamp used on the Providence circuits. Mr. Junkersfeld expressed doubt if a 250-500-volt system has any advantage over the 125-250-volt system. In the incandescent lamp system there is a considerable difference in the energy loss, owing to the use of low-efficiency lamps, and the arc lamp situation is even more serious. The meter losses are double and the meter slip in the course of a year should amount to a very considerable item. While the difference in the investment required may offset these disadvantages, the adoption elsewhere of the system should be a matter to be very carefully considered. Even under circumstances where it might appear particularly adapted the straight alternating-current system would be a serious competitor. Mr. Alexander Dow thought that with the neutral earthed at different points there would, in towns where there is an electric railway system, be a considerable flow of railway current through the neutral circuit of the lighting system. In a case which came under his observation where two earths were on the neutral three-wire system about 8,000 feet apart, there was a maintained difference of potential of 10 volts during the evening peak of the electric railway load, this resulting in serious disturbances of regulation and necessitating a special provision for balancing the three-wire system at different points. At times in such cases the current may be so large as to seriously heat the conductors.

E. H. DAVIS.
President National Electric Light Association.

Mr. Woodward said that in Providence the lead sheaths of all cables are bonded together in every manhole and there is in every manhole a ground plate bonded to the sheaths and to the copper neutral. In several years' operation no trouble was met with from railway current except in one section of the city very near to a point where the railway cables cross the river. Replying to Mr. Junkersfeld criticism, he said he understood that by "slip" was meant unaccounted-for meter current, and he failed to see how there would be any more slip with 500-volt meters than with 250-volt meters. When it is considered that a single sub-station with a 250-500-volt, three-wire system would cover sixteen times the area that could be supplied from a sub-station operating at 125-250 volts, it would seem a system using the higher voltage would be the better. As to alternating-current competition, he did not see how all classes of motors and all classes of lighting could be supplied with alternating currents at all times, he did not know of a single central station supplying a large area where variable-speed motors are used which has confined itself to alternating-current supply alone. Mr. H. L. Doherty, referring to the matter of meter slip, said that since the torque on the meter is proportional to the amperage and as current is supplied at a higher voltage, the slip would be doubled. As an example of what meter shunt losses may mean, he cited an alternating-current circuit at Madison, Wis., where the shunt meter losses amount to more than the core losses of the transformers. Mr. P. G. Gossler, referring to the wiring of the Union Trust Building in Providence, the frame of which is used as a neutral conductor, asked what the practice was in buildings not having metallic frames. In reply Mr. Woodward said that in these cases a copper neutral would be run.

The Luminous Arc

was the title of the next paper, which was read by the author, Mr. W. A. Holmes. The paper described a new form of arc lamp in which a magnetite electrode is used instead of the usual negative carbon and a copper block instead of the usual positive carbon. The lamp is described fully in another part of this issue. According to the author of the paper, a magnetite lamp requiring 320 watts gives somewhat more illumination than an ordinary 340-watt open arc or a 450-watt enclosed-arc lamp. With ½-inch magnetite negatives, an average life of 100 hours has been obtained in the Newton (Mass.) plant. In the ensuing discussion, Mr. Holmes said that there was practically no deterioration of the copper electrode, and that the citizens were very much pleased with the illumination obtained.

The Committee on the Standard Rating of Incandescent Lamps, Dr. Louis Bell, chairman, then presented its report, in which it was stated that at present primary standard lamps can be procured from more than one concern and in general the conditions relating to standardization of lamps have become such that it is hardly necessary to make an extended report. Dr. Bell felt that the work of the committee was pretty much accomplished when standard lamps could be easily obtained and a general understanding was arrived at as to what would be desirable in the rating and measuring of lamps, and consequently asked that the committee be discharged. He recommended that in the case of reports of technical character there should be closer co-operation between members of the association. A proper method of doing work of this kind would be to send to all members of the association a circular asking for detailed statements of conditions as they find them, and the answers should then be digested and printed as a confidential document, so that every member of the association would know what the other members were doing. At a following convention a special or general committee could report on the data thus obtained and every one who had participated in gathering material for it could then discuss the situation to the best advantage.

Mr. Robert Howes then read a paper on

A One-Hundred Mile Transmission Line

which was substantially a description of the transmission plant of the Washington Power Company, Spokane, Wash. The pole line is 98 miles long, from the power house to the farthest sub-station, with three short branches. It transmits power at 45,000 or 60,000 volts, according to conditions, the step-up transformers having taps which permit this. On leaving the power house the line passes along the city streets for 3½ miles on poles ranging from 45 to 85 feet high; wherever it crosses other lines, grounded wires are strung over the other lines several feet below the transmission line. In crossing a swamp, each pole is set in a "socket" formed by the upper ends of five piles, the central one of which is driven six feet lower than the other, thus forming the socket in which the line pole is firmly clamped with heavy iron bands. No. 2 B. & S. medium hard-drawn copper wire is used. At present unity power factor is usually reached with a load of 1500 kilowatts, the current in the line being then about 18.5 amperes. The line has been in operation for over seven months, during which time the circuit breaker has been tripped eight times. In two cases this was caused by accidental short circuits on the line made by the company's workmen; in four cases the cause was a short circuit on the secondaries of customers, and the other two cases were from unknown causes. The total time power was cut off by these troubles was 32 minutes.

After reading his paper, Mr. Howes stated that since it was written they have succeeded in holding the voltage at Spokane practically steady, there being a variation not to exceed ¾ volt above or below normal on a 116-volt basis, and at the far end of the line the variation was cut down to a trifle over one-half. This was accomplished by means of the installation of a voltage regulator. A controller was then installed on the induction motor at the far end of the line, which again cut down the variation one-half. In reply to an inquiry he said that power had never been cut off except to cut in sub-stations, at which times advantage was taken of the opportunity to renew insulators which have been broken by boys throwing stones and shooting rifles at them, making targets of them at rifle practice. In reply to another inquiry he said that they have had a number of severe lightning storms, which are much more frequent in that locality than in the Eastern and Middle States, but they had never experienced any trouble from lightning. During one storm, however, the insulation of a transformer for operating high-tension circuit breakers in the sub-stations was punctured, which caused a shut-down of ten minutes. This was just before another shut-down of nearly an hour caused by a road supervisor putting several pounds of dynamite under a stump of a tree and blowing it skyward through the wires.

Dr. Bell called attention to the fact that people apparently expect of induction motors a greater degree of immunity from troubles produced on the line, and with others that motors are heir to than in the case of direct-current motors. Large induction motors should have the starting rheostats very carefully designed and this is usually not done, the lower steps of the starting rheostats in three cases out of four not being made for the fine gradations that are necessary. With proper attention to the starter relatively little trouble will be encountered with large induction motors. He believes it advisable to run a little under unity power factor all the time, never giving the current a chance to become leading and thereby introducing oscillatory factors, with magnetizing and demagnetizing action on the generator acting in quicker succession in response to changes in load.

A somewhat elaborate paper was next read by Mr. George N. Eastman on

Grounding the Neutral on High Potential Alternators,

in which the author presented a mathematical demonstration to show that the advantages that may be obtained by insulating the neutral of a high-tension alternating-current system from the earth will be more than offset by the liability of developing abnormally high potentials relative to the earth. The paper was based on a consideration of the three-phase, four-wire system of the Commonwealth Electric Company, of Chicago, and was illustrated by diagrams showing the voltages obtained with wholly insulated and neutrally grounded circuits. The author expressed the opinion that a proper method of grounding the neutral of generators is through as low a ground resistance as can possibly be obtained, in this manner fixing the maximum potential which can be obtained between a system and ground at the normal potential which will exist between the neutral of the generator and its phase terminals. The systems of the Chicago Edison Company and the Commonwealth Electric Company have been operated with a grounded neutral for a period of four years, during which they have apparently been entirely free from the high-potential break-downs that have occurred on other systems of a similar character entirely insulated from the ground.

Mr. Hallberg said that the Cincinnati Gas and Electric Company had operated a system during the past four years similar to that referred to in the paper and with unquestioned success from the practical point of view. He considers it to be by far the most simple and reliable system, and the regulation seems to be everything that could be hoped for. In Cincinnati there has been practically no trouble from lightning, the neutral, if anything, protecting the system from lightning discharges. He recommended, however, that since the primary neutral is grounded all secondaries should also be grounded.

The Organization and Equipment of an Arc Lamp Department

was the title of an interesting paper read by Mr. Samuel G. Rhoades, of the New York Edison Company. Mr. Rhoades' paper was based on his experience with the arc lamp department of the New York Edison Company. The paper contains reproductions of seven printed cards and slips used in the system, and gives illustrations of a carbon cutter and punch for cutting washers, an inner globe washing machine, a "shepherd's crook" lamp post and a supply wagon. The method of keeping track of every detail connected with an arc lamp system is described, and the duties of the various classes of employes are detailed. In turning on and off direct-current multiple lamps boys, preferably over fourteen years of age and almost exclusively school boys, are employed, receiving $2.50 weekly for forty-five minutes' actual switching work both night and morning. Three men in charge of the boys cover the entire city of New York.

In the discussion of the paper by Mr. Rhoades it was brought out that during the past several years the arc lighting business appears to have come to a halt. Mr. Gilchrist, of Chicago, said that recently he had noticed a tendency on the part of the general public to use arc lights again, but he thinks this is due to a more strenuous effort on the part of central station people on account of sharp competition from various types of special gas burners on the market, and which are strong competitors to the arc light. Mr. Rhodes said that the advance made in New York has really been the work of the contract department. The lighting engineer is a new departure; when trimmers report that any customer's lamps are acting badly the lighting engineer or one of his assistants is around the next day to remedy any defect. Many people have changed over from the Kitson and Humphrey gas burners, the operation of both of which, especially in the winter time, is very bad. He considers the 3.25-ampere lamp very useful, for if the customer does not want to pay for a 5-ampere lamp he will probably be willing to take a lamp of the lower consumption. Mr. Douglass Burnett, of Baltimore, said that there is little difficulty in getting arc light business now when the solicitation is properly done. The customer should be assisted in locating lamps and sometimes given sketches with a general outline of a scheme for his lighting. For example, he may be advised that for the interior of his store he requires a 5-ampere lamp for every 300 square feet of floor space, the lamp to be located with the arc about 12 feet above the floor level. For the windows incandescents should be recommended. Arc lamps in the interior of a store will show goods better than anything else to customers, and he cannot produce a brilliant effect in front of the store with interior incandescent lights. In fact, the prospective customer should be advised on every point calculated to make his lighting most effective. He considers that the problem still remains as to how to develop the series arc lamp service.

Mr. Rhoades said that while in the case of large contracts the New York Edison Company does not care for the lamps, yet they keep their eye on the installation and freely offer their service whenever it appears to be called upon. As to maintenance of arc lamps, one trimmer at $14 a week, seven days, will take care of 650 lamps; in the repair shop one man at $3.50 a day and the rest at $2 per man, will take care of 2000 enclosed lamps. Mr. Burnett said that in Baltimore he also used night linemen in the various districts, who were available in case of either an open or a grounded circuit and for switching electric signs on and off again. In reply to a question it was stated that the New York Edison Company and the Omaha Electric Light Company furnish diffusers free to their customers, and Mr. Fleming stated that the General Electric Company will adapt its diffusers to any type of lamp.

Mr. James I. Ayer read a very interesting paper on the subject of

Electric Heating and the Field it Offers to Central Stations,

in which he pointed out that electric heating apparatus may be used to advantage under certain conditions and when intelligently handled; for example, small heaters, used intermittently and turned off when not actually in use. He enumerated a considerable list of such devices, which are supplied with connector plugs to fit lamp sockets and do not need to be in circuit more than ten to thirty minutes, making but a small addition to the monthly light bill. Concerning electric cooking, he said that electric cooking apparatus operates at an efficiency of about 70 per cent, while gas averages only about 15 per cent time efficiency in domestic kitchens. Assuming gas to average 700 heat units per cubic foot, the drop in the circuit between the meter and electric cooking utensils to be 1 per cent, the efficiency of use to be 15 per cent for gas and 70 per cent for electricity, he showed that in order for electricity to compete with gas at equal rates the following prices would need to be quoted for electric service.

Per kw.-hour.	Per 1000 ft.
5.67 cents, if gas is	$2.50
4.54 cents, if gas is	2.00
3.4 cents, if gas is	1.50
2.83 cents, if gas is	1.25
2.27 cents, if gas is	1.00

In a family of four or more persons, he said, electric cooking will require from 1 to 1.5 kilowatt hours per day per person; recorded data show an average about 20 per cent below the higher figure. The cost of heating water from 60° to different temperatures, he gave as follows:

One Gallon of Water; Initial Temperature 60° F.

Ultimate Temperature.	Watts used for			Cost in cents with current at		
	10m.	20m.	1 hr.	3c.	5c.	10c.
100° F.	648	324	108	.32	.544	1.088
150°	1488	744	248	.74	1.24	2.48
175°	1872	936	312	.94	1.56	3.12
200°	2304	1152	384	1.15	1.92	3.84
212°	2496	12.48	416	1.25	2.08	4.16

The equipment of domestic laundries, he said, will be found a profitable field by central stations. A family requiring but one iron will need a size using about 500 watts and the service will range from 2500 to 5000 watt-hours per week. It is not possible to do ordinary house or office heating unless current can be supplied at exceptionally low rates. Even for cooking and laundry work, special rates, lower than lighting rates, are essential, but as the load is chiefly a summer day load, specially low rates are possible and the business is desirable. In the discussion which followed the reading of the paper, Mr. Ayer recommended that the policy generally followed with regard to arc lamps be adopted in the case of electric heating apparatus, namely, that heating outfits of all kinds should be provided free by the central station. The average kitchen for a family of from four to eight persons involves a transformer capacity of about 30 amperes and 3 kilowatts. The average demand of a family of this kind is about 20 amperes and 2 kilowatts at the cooking hour, or about two-thirds the house service. Most of the load for cooking is over by 6 o'clock, so that at most seasons of the year it would not coincide with the peak load.

Mr. Alexander Dow, of Detroit, said that in Detroit the peak load is in advance of the general maximum lighting in the residential districts, coinciding with the down-town peak. Electrical cooking would add to the main station peak load, but for winter service only. The cooking load is about two hours per day throughout the year. It does not do to sell cooking apparatus unless it is looked out for. An absolutely clean, smooth vessel is better than the ordinary cooking utensil, and the best one is a type of vessel which clamps solidly to the disk. The conducting cords are a nuisance, and he suggested that they should be passed through a hole in the table as in the case of telephone switchboard cord. The devices furnished by various makers for varying the heats are about useless in the hands of the ordinary kitchen servant. He considers that two heats are practically sufficient—one quick and one simmering heat—and that these can be obtained by a double-throw switch, which when open cuts the heat off altogether. The worst fault to be found with electrical cooking to-day is in the repair bill, which is a very serious matter.

Mr. Arthur Williams spoke of the desirability of circulating among electric light users information relating to electric cooking, and said that the New York Edison Company has recently been doing this extensively. He thinks electric cooking apparatus will never give to the companies a large revenue, since its use is confined to short periods of the day, but aside from cooking the late afternoon dinner in the winter months, whatever revenue comes from this apparatus is additional per kilowatt of installation. This in itself should encourage effort toward installing electric heating and cooking apparatus. In the months of June, July, August and September the load will not come on at the peak, and in view of this it might be well to adopt the English method of making a lower charge for the current used during these months. He considers that every large device connected with electric cooking should have an indicator which cannot be removed and which will show when current is on and off; he has known of cases where the colored lamps supplied with cooking apparatus have been turned out and the current left on. In one case the current was left on an electric heater during the entire summer season in the absence of the owner. He cited a case of a large factory where electric irons are used for making hats; the price paid for current is 8 or 9 cents per kilowatt hour and the cost of this service is almost identically the same as that of the former service rendered by gas. The advantages in the use of the electric heating iron are that the men work faster, thus increasing the output; the factory and the men working there are kept cleaner; the atmosphere is cooler and working with the electric iron is much less fatiguing to the employes.

Lost and Unaccounted-for Current.

Mr. C. W. Humphrey gave an account of the method used by the Denver Gas and Electric Light Company for determining the losses, known and unknown, from alternating and direct-current circuits. The losses are classified as transformer iron losses, primary resistance losses, secondary resistance losses and meter shunt losses. The methods employed by the Denver Company for determining these losses are given in detail, the paper containing reproductions of forms and curves employed in this work. It was found that the greater part of lost and unaccounted-for current was due to thefts. The author cited an instance where, through proper attention to reducing losses, the ratio of sales to output increased from 59.3 per cent to 80.5 per cent. In another case, where a feeder was changed from a 1000-volt individual transformer to a 2000-volt, three-wire secondary network, there was a reduction in transformer iron losses of over 60 per cent. In this instance the sales were increased to nearly the original amount and the transformer iron loss reduced to about one-half the original amount, though the primary and secondary resistance losses were increased considerably through the increase of the output of the feeder. In the case of a principal business feeder the watts per lamp of output remained about the same for the entire year, while the watts per lamp of sales increased during the same period to nearly double. The sales increased from 41.6 per cent to 83.5 per cent, the known losses remained about the same, while the unknown losses decreased from 48.4 per cent of output to only 5.22 per cent. A check meter placed in a district having nine ampere-hour meters and eleven integrating wattmeters showed a loss in the district of 8.1 per cent, not including about 2 per cent wattmeter shunt losses. The larger loss was principally due to the ampere-hour meters, which do not start on less than two to four 16-c.p. lamps.

Economy in Minor Station Supplies.

In a paper with this title, Mr. Edgar B. Greene discussed the care of minor supplies in stations of moderate size. In his station there is a course of training which starts a young man as an apretice either in the steam or electrical side of the plant, and gives him a thorough training in all branches of the work. There is no definite period for this course, the apprentice being promoted as fast as his ability will warrant, there being a distinct understanding that each person must earn his promotion or stand aside for the next man. A number of the apprentices take a course in correspondence schools and this method of education is strongly endorsed. The paper referred to a number of minor economies such as standardizing pipe nipples and valves, using tubing in steam hose for cleaning boiler tubes, and a home-made arrangement for bending tubes was described. A lathe was installed for making simple repairs. The ashes and cinders are carted away free by a railroad company and others having use for them. Arc dynamo brushes are made from strips of hard-rolled copper 0.01 inch thick; four of these are soldered and a phosphor-bronze strip 0.02 inch thick is used as a stiffener. All oil from the engines is drained by gravity direct to the oil house, where it is filtered by a home-made apparatus. Defective coils of arc lamps and Thomson recording wattmeters are rewound in the station, as well as all transformers. In reading the meters the routes of the men are changed monthly, and different men instead of the same man are used for this service. After the inner globes of enclosed arc lamps are washed they are tested on a ground steel plate for the closeness of joint and then fitted to the holders, the lower holder being trimmed in the station. At least three days' supply of inner globes are always in course of cleaning or washing, which keeps two days' supply ready for use. With a new man the average life of the inner globe is about 800 lamp-hours for the first month and afterwards from 1400 to 1500 hours; the number of lamp-hours per carbon is found about 10 per cent shorter with a new man on the first month.

In the discussion of Mr. Greene's paper, Mr. W. L. Abbott, of Chicago, said that he knows of nothing which will introduce discord in the operating force so promptly and so continuously as placing an outsider in one of the higher positions over the heads of men who have worked faithfully for years. He has known of cases where discord thus produced has been so great that it was necessary to discharge the entire original force. Concerning oil filtering, he considered there were two functions to be performed, one to remove the grit and the other to remove grease and water from the oil. By removing the water and grease in the settling chamber, he has found there is no need of a filtering material in the oil filter.

Mr. E. E. Arnold contributed a lengthy paper entitled

Notes on the Internal Combustion Engine as Applied to Central Station Service,

in which, after briefly outlining the theory of the gas engine, he gave data as to test performances and described and illustrated a number of central stations equipped with Westinghouse gas engines. The paper contained a table giving the results of tests for a large number of gas engines of this type.

Test of a 5,500 H.P. Compound Engine and Generator,

was the title of a paper read by Messrs. J. B. Andrew and W. F. Wells which gave the data of a test of one of eleven three-cylinder, 5500-h.p., vertical compound engine units installed in the Waterside station of the New York Edison Company. The method of test is described in detail and much of the data is plotted in the form of curves. The test showed that for outputs of from 2500 to 4500 kilowatts the steam consumption varied between 17.12 and 18 pounds per kilowatt-hour of net output at the generator terminals. The best test showed an economy of 11.93 pounds of water per indicated horse-power-hour or 16.78 pounds per kilowatt-hour. The tests indicated a decided disadvantage in the use of a receiver reheater and steam jacket in this type of engine. The curves show an almost absolute uniformity of economy for a considerable range on either side of the normal rating. Increasing the vacuum from 25.3 to 27.3 inches decreased the water consumption only 0.06 pound, whereas increasing the receiving pressure from 21 pounds to 36.8 pounds, or changing the distribution of load from about ⅖ on the high pressure cylinder and ⅗ on the low-pressure cylinder, to about equal load on all three cylinders, decreased the water consumption 0.25 pound.

Mr. Francis Hodgkinson contributed a paper entitled

Practical Notes on Steam Turbines,

in which, after discussing the principles of this type of prime power, brief descriptions were given of the De Laval, Stumpf, Curtis, Zoelly and Rateau turbines, the remainder of the paper being devoted to the Westinghouse-Parsons type. A considerable portion of the paper was devoted to foundations and power plan designs for Westinghouse-Parsons turbine electrical equipments.

The papers by Messrs. Andrew, Arnold and Hodgkinson, and the report of the Committee of Investigation of Steam Turbines by Mr. Eglin, were discussed together. In opening the discussion, Mr. Ralph D. Mershon said he noted that in the gas engine plant on which Mr. Arnold gave figures, nothing was allowed for relay capacity, and if this were done it would mean a greater investment to the disadvantage of the gas engine. He has found that most gas engine builders rate their engines at or near the maximum load they will carry, whereas the steam engine is rated so as to have a considerable overload capacity. He considers that the gas engine should be figured as having a less efficiency at lighter loads, as compared with the steam engine. Referring to the figures given by Mr. Arnold as to cost per kilowatt of steam and gas installations, namely, $100 and $125, respectively, he thought that the figure for the gas engine should not be under $150 and nearer $175.

Mr. Doherty said that the serious drawback in gas engine development is in securing economical and satisfactory transformation of the heat energy of coal into gaseous energy. Mr. H. G. H. Tarr spoke of the reduction of cost to be obtained in the generation of gas through utilizing the by-products. In one process, if the coal is worth $2.50 per ton, the by-products reduce the cost to the equivalent of $1.50 per ton, these figures being applicable to larger plants of, say, 50-tons capacity in 24 hours and above. A producer using bituminous coal will cost from $17 to $20 per horse-power. Mr. W. R. Gardener suggested that peat might possibly be used to make a producer gas at low cost.

Mr. R. H. Rice, of Lynn, Mass., in answer to a request, gave a description in detail of the Curtis turbine. Up to and including 300 kilowatts this turbine is constructed in the horizontal form and in the vertical form for larger outputs. All large Curtis turbines are made now with four stages. He cited a case where only two reciprocating engines of 500 kilowatts capacity could have been installed in a certain power house, where five turbines of the same size were readily located.

Mr. H. L. Doherty spoke highly of the prospects of the gas engine, and said that to-day practically every authority on thermodynamics believes the ultimate prime-mover will be the internal combustion engine. In his opinion the steam turbine will be left behind by the internal combustion engine, which will unquestionably be the eventual prime mover. To get the best efficiency in the gas engine it should be operated at its maximum capacity, since the losses are 25 per cent of the capacity, no matter what the load. Gas engines cost more per horse-power at the start and the fixed charges are consequently heavier. It is, therefore, desirable to operate the gas engine the longest number of hours, and an ideal arrangement would be to use a gas engine to take care of that portion of the load which is on 24 hours a day, the variable load being taken up by steam engines. He endorsed a statement by Mr. Arthur Williams that the present gas engine is relatively no better developed now than the steam engine was during the life of Watt, and he believed the gas engine has wonderful possibilities ahead. He thought that the question of the gas producer is not receiving in this country the attention which it deserves and which is being given to it in Europe. As to the smaller space occupied by the steam turbine in his work he had found that he could not always avail himself of the lesser space indicated by the turbine without the use of a system of steam piping that would not be good engineering practice. Several methods have been proposed to reduce the space occupied by boilers. One is to have the boilers installed back to back, giving a double boiler room with the firing door on the side, the steam piping being led from one firing alley to the engine room. Another plan is to build the boilers with the firing doors at right angles to the turbine and have short alleys running up to the groups of boilers. Another way is to design a special boiler having little width and considerable depth, this probably involving a vertical boiler. Another method suggested but not looked upon with favor was to put the boiler room on each side of the turbines. As to condensers, Mr. Doherty says he has never been able to satisfy himself that he cannot get a higher vacuum from a jet condenser than a surface condenser, and he hopes next year to have some definite figures on this subject. The question of superheaters is a rather serious one, for it is difficult to control the degree of superheat and the tubes burn out.

Mr. Arnold, in referring to Mr. Mershon's remarks concerning the rating of gas engines, said that these are ordinarily rated at a brake horse-power of 15 to 20 per cent under maximum capacity. Steam engines are rated on their indicated horse-power with, say 50 per cent overload, but the difference between indicated and brake horse-power amounts to considerable, and the actual capacities of the two types of engines approach more closely than would ordinarily be supposed. As a lighting station has ordinarily a 20 per cent load factor, the relay capacity is well taken care of in the way the units are laid out in the case Mr. Mershon criticises. Smaller gas engine units of approximately the same efficiency as large gas engine units, and the smaller gas engines, are notably more efficient throughout their range of load than the steam engine. As to the relative efficiency of the gas engine at light loads, he referred to a curve in his paper showing that at half load the brake thermal efficiency of the engine was 21 per cent, while that of a steam engine of the same capacity would only have a corresponding efficiency of 10 per cent. As to the depreciation and life of a gas engine in comparison to the steam engine, experience points out that the former quite holds its own with respect to depreciation, though it will perhaps be found that it costs slightly more for horse-power repairs than the steam engine equipment, excluding the more intricate designs of multiple-cylinder, releasing-gear steam engines using superheated steam. He cited a lighting station having a 24-hour service equipped with 800 horse-power rated capacity in gas engines in five units, complete repairs for which in the year 1903, including repairs to igniters, cost only $102, or something less than 13 cents per horse-power per year. In reply to an inquiry he said that all plants referred to in his paper are connected with alternating-current generators operating in parallel, and many of the plants are giving a 24-hour service. He referred to a 3000-h.p. gas engine cement plant which operates 24 hours a day and has been in service about four years.

Mr. Edwin Yawger read a paper entitled

The Mechanical Stoker and the Human Operator

which is printed almost in full elsewhere. In the discussion of this paper Mr. C. H. Parker said that the higher the temperature of a furnace fire, the better the furnace efficiency. Flue gases analyzed with low fire temperature show a large excess of oxygen. When the grate combustion is run up to 40 or 50 pounds per square foot rate, the excess air is brought down something like 30 to 40 per cent, and the fire is a dead white. Better economy may be obtained by reducing a grate area and using a greater number of pounds per square foot, and also per square foot of heating surface. Mr. R. S. Hale, of Boston, said that after analyzing a great many boiler tests he had reached the conclusion that, other things being equal, the less draft used the higher will be the efficiency. If it is a question of getting a greater capacity, then of course, a greater draft must be supplied, or if a grate surface is cut down more draft must again be supplied. He disputed the statement of Mr. Yawger that the same volume of gas at the same temperature will give up more of its heat when passed rapidly over a heating surface than when passed slowly. On the contrary, better efficiency is secured by passing the gases more slowly over the heating surface. One reason why the best efficiencies are gained with a low draft is that this implies more careful firing in order to keep up the capacity, and hence reduces the amount of air used, thereby reducing the loss of heat in the waste gases; and since the gas is passed more slowly over the heating surfaces, they give up more of their heat.

The Doherty Medal.

Dr. S. S. Wheeler, chairman of the committee on the award of the Doherty Gold Medal, said that of the various papers submitted on the subject of underground construction, there were two excellent ones, one by Mr. W. P. Hancock, of Boston, and another by Mr. Blood, of the same city. While the paper by Mr. Blood was very good and exceedingly well composed, it was unanimously decided to recommend the award of the prize to Mr. Hancock. Mr. Edgar presented the medal to Mr. Hancock, and said that his career had been passed with the Boston Edison Company, of which he is now general operating superintendent, and the designer of the two station to be visited by the members. In accepting the awarding Mr. Hancock said he wished there were a greater engineering interest in underground construction. The subject is an extremely important one and should be given close attention.

Mr. C. L. Wakefield presented a short paper entitled

Electric Light and Power Plants in Connection With Ice Plants,

in which he gave the result of correspondence with about 50 plants supposed to have an ice plant auxiliary. The results showed that very few of the plants were actually so equipped, and with three exceptions, where there are equipments they have been installed without any particular purpose. In his station a 300-kw., alternating-current plant operates a 100-ton ice-making plant with the addition of one oiler and one fireman to the regular force. The fuel cost per ton of ice varies from 350 to 700 pounds of coal, depending upon the calorific value of the fuel and the manner of its use.

Mr. Scheuck thought that it was a bad plan for electric light companies to operate ice plants or enter into other classes of industry, excepting steam heating, for the reason that it was likely to antagonize municipally influential persons who might be interested in competitive ventures.

Decorative and Sign Lighting.

The report of Mr. Arthur Williams on this subject was presented in a beautifully executed pamphlet containing a large number of views of New York City buildings and interiors, and reproductions of letters printed on toned backgrounds. The illustrations were mostly views of facade lighting of theatres and other buildings, with some views of interior lighting, the most striking being a representation of the Waldorf ballroom on the occasion of the A. I. E. E. annual dinner. The letters are principally reports from electrical companies on the subject of decorative and sign lighting. Following Mr. Williams' report, Mr. La Rue Vrendenburgh presented his report on

Advertising Methods.

This related principally to the methods of advertising that have been employed by the Boston Edison Company. Reproductions are given of a large number of newspaper advertisements and of electrical signs soliciting central station business, and the text points out methods pursued by several of the larger companies in soliciting business.

The reports of Messrs. Williams and Vredenburgh's papers were discussed jointly. Mr. Scheuck said that methods which might pay in large plants could not be afforded by companies in smaller cities. Mr. Williams' and Mr. Vredenburgh's methods were undoubtedly of great efficacy for the large companies, but there were only a few companies in the United States which could afford them. He was connected with several plants in smaller cities, these plants doing both railway and lighting business. He had found one of the best methods of getting new business was to print small booklets and to supply them to metal holders in the street cars each day. In a town of 50,000 inhabitants he had begun with an issue of 4000 booklets a week and had had to increase the number. The booklets contain humorous items interspersed with advertising arguments; he found that people would take these booklets home, and that they had been the means of increasing his lighting and power business. Another method of extending power business is to go to small factories and shops already equipped with motors, but not intelligently so; to re-equip them so as to secure higher operating economy and take photographs of the meter bills before and after the change, using these photographs as advertising material. He advocated making very low rates to stores for electric signs, show window lights, etc., and taking special care to see that the stores maintained their signs and show window lights in good condition. Mr. Scheuck also pointed out that the lighting company's office should be in a good location and well illuminated at night in order to make a good impression on the citizens. Mr Converse D. Marsh disagreed with Mr. Scheuck as to the efficacy of his methods. He thought that methods of getting new business should be the same in character in smaller plants as in large ones, differing only in degree. Promiscuous distribution of booklets he did not consider efficacious. Solicitors could not know who had been reached by the booklets, so that a follow-up system could not be applied; the booklets alone certainly would not bring a man up to the point of signing a contract. Mr. Burnett also disagreed with Mr. Scheuck. He was connected with a company in a city of moderate size and had obtained good results by furnishing free electric signs in order to obtain the resulting business. President Edgar, in response to an inquiry by a member, said that the Boston Edison Company spent 5 per cent of its gross income in advertising and soliciting new business, this amount being about equally divided between the two branches.

The report of the Committee on

Purchased Electric Power in Factories,

consisting of Messrs. W. H. Atkin, chairman; S. Morgan Bushnell and G. W. Brine, gave the result of inquiries made by circular letter concerning the use of electric power in factories. The letters were sent to all of the members of the association and asked for answers to 13 questions relating to the charge for power, kind of factories supplied, increase of power business, decrease of production cost from use of electric power, kind of electric drive, amount of power sold, etc. To 462 circular letters sent out 61 replies were received. Of these 19 reported no sales of factory power, 11 either gave no information or answered but one or two questions, and 31 replied more or less fully. The average increase of power business of 24 companies reporting was 37 per cent, a larger amount of increase than the lighting load. The rates reported range from 2 to 15 cents per kilowatt-hour, the usual range being from 4 to 10 cents. Among the conclusions of the report are the following:

The sale of electric power by central stations to factories has been limited largely to such industries as have to carry on their business in the centers of cities or towns where space is costly and where the trouble and danger of steam engines become large factors. The great industries of boots and shoes, cottons and woolens, usually produce their own power.

Among printers there is a large patronage from "job shops" and a good proportion of the newspaper offices, but practically none from book printers, whose "runs" are long and whose "make-readys" are comparatively short.

The committee considers that the best method to increase business is to educate the prospective customer. Although electric power has been in use for 15 years, it is not yet the first power of which a man thinks when he is about to start a new factory If the central station could have its solicitor on hand to explain the advantages of electric drive over mechanical drive before the prospective customer has purchased his gas engine or steam engine, or made his contract for power from a belt, a great amount of business might be obtained which is lost simply through unfamiliarity with electric power on the part of the power-using public. In this connection it is of the highest importance that the solicitor be thoroughly conversant with different manufacturing processes, and be a man of great power of observation, so that he can take in the situation quickly and give the customer the needed points which will "tell" and turn the scale to electric drive supplied from central station.

After a customer has been secured he should not be left to his own resources, but should be advised as to the number of motors to purchase and their arrangement. Careful attention to the details of installations at the time the motors are purchased will effect economies, and these will go to the credit of the central station service. The customer is naturally quite reluctant to buy several motors, when, so far as he can see, one will do the work just as well; but the solicitor should have at hand facts and figures that will prove conclusively that the extra motors will return a good dividend upon the investment, and that with the individual motor equipment or the group drive, the central station can supply power more cheaply than the customer can produce it himself.

One great point of economy which should be looked after is the use of the electric elevator in place of that operated by steam or hydraulic power. In many factories may be found a slow-speed freight elevator driven by belts from the main shaft. This can always be changed over and connected to an electric motor without calling on the elevator makers and at comparatively small expense. Another important feature in central station service is the facility with which any single department can be run overtime. This often avoids the employment of inexperienced help, and enables the manufacturer to respond more promptly to any unusual demand. Another exceedingly important factor in the advantages of electric power is the ease with which a plant can be enlarged by merely buying additional motors from time to time, instead of taking out and discarding an overloaded steam plant, and putting in a new one at enormous expense, or at least adding long lines of shafting and belting.

The ability to move machines about, taking the tool to the work, instead of the work to the tool, is often a great advantage in large establishments, and this may be done with the greatest facility when tools are directly connected to electric motors. The time saved by this arrangement in shops handling large masses of metal would pay a very large dividend on the investment in motors. The cleanliness of a shop supplied with motors instead of with shafting would be a revelation to one who was not familiar with the results which such a change in power produces.

Heating from Central Stations.

The report of the Committee on District Heating, consisting of Messrs. E. F. McSherman, D. F. Magee and C. M. Maunsell, gave the results of inquiry made among central stations operating steam and hot water systems. Of 100 companies addressed, 52 replied, including 36 operating steam and 16 operating hot water systems. The report gave in tabular form the replies to the 24 questions propounded. The conclusions of the committee were that as a whole it seems clear that the companies now in the heating business are in general making money. Out of the 35 steam systems 31 stated and showed by the figures returned, that they were well pleased with the investment. Out of 15 operating hot water systems, 11 were satisfied and 4 were not. The best financial showing is made by those companies basing their charge on readings by meter and cubic feet of air space, which insist on the use of economizing coils, inspect and supervise the installation of buildings and refuse to connect or give service to poorly designed heating systems; and which keep separate accounts of heating and electrical revenues and expenses, and recognize the value a heating system has as an auxiliary to electric light and power supply. It is at least a coincidence that the companies making the poorest financial showing are those that, from a lack of knowledge of what they are actually doing, are unable to make definite or explicit replies to some of the questions asked.

The important matter of depreciation has not had the consideration that should be given to it; only 21 of the 52 companies reporting have seen fit to provide for this. Most companies report low cost of repairs, one that has been in business for six years reporting only 2½ per cent on mains and services. The question of returning condensation to the power house seems to be one related to local conditions. Very few express themselves favorably on constructing a plant for this purpose, though a few are much in favor of it, probably owing to the local situation. The replies seem to indicate that district heating is now a success and could be made more so if central station managers were to co-operate with the committee for the general good. The paper gave the full text of the replies received from all of the central stations which reported.

In the discussion, Mr. McCabe, in answer to an inquiry, said that of the fifty-two companies that had replied to his inquiries only five or six had made any charge to cover depreciation on mains, etc. One company which had been in the heating business fifteen years charged 2½ per cent to depreciation. Another company which had been supplying heating service for eight years made no charge. Mr. McCabe thought that the depreciation should be taken into consideration, but that it would be small. He also pointed out that the supplying of heating service enabled an electric light plant to get lighting business in office buildings and other large establishments, which, if they had to maintain heating plants, would also operate their own lighting plants.

Office Methods and Accounting.

Mr. Frank W. Frueauff, in his report on office methods and accounting, confined himself to an account of the methods used in the offices of the Denver (Colo.) Gas and Electric Company. The author advocated the plan of apportioning the cost of operation to the class of current made and of separating fixed and variable costs. The expenses occasioned in manufacturing and distribution for any one class of current should be kept distinct from those incurred in another, so that the actual cost of manufacture and delivering arc power and alternating current may be known separately. The cost for any one class should also be separated to show the costs that are fixed as distinct from those that are variable. For example, station foremen, meter department, shop expenses, etc., are practically a fixed expense, not varying notably as the business increases or decreases. Boiler fuel, firemen, lamp renewals, carbons, etc., vary with output, and under a third head may be included meter, arc lamp and service repairs, meter reading expense, collection and office salaries. With the cost for any class of current separated into these three divisions, it is possible to know just what results are being obtained, and this method is particularly valuable in figuring rates to be made to secure new business. For example, in figuring to take on a long-hour burning customer, it is known from the figures of cost that the fixed cost will not be materially increased nor the consumer's expenses, and that only the output cost will be increased.

Standard Instruments for Central Stations

In a paper entitled "A Proposed System of Standard Instruments for Operating Companies," Mr. H. P. Davis, after sketching the desirability of accuracy of central station measuring instruments, and consequently the necessity of reliable standards for calibration purposes, suggested that a remedy for the present unsatisfactory condition in these respects may be offered by the manufacturers of high-grade electrical instruments. The service rendered by manufacturers of such standard instruments could advantageously cover their care and recalibration after they were put in the hands of purchasers. All the conditions of manufacture combine to make the manufacturers of such instruments the best able to care for them thereafter. To render the best service under the plan suggested, the manufacturers of the instruments should make no charge for recalibration and should see to it that prompt return is made to the owners. It might even be found advisable to ask owners to send in instruments to be checked when a considerable period has elapsed without such attention. The owner would be at no expense, except for carriage, and should have no hesitancy in sending his instruments to the maker for attention when desired.

Mr. W. A. Layman read a paper on

Single-Phase Power Motors for Electric Lighting Stations,

which treated the subject under the following heads: Reliability of single-phase motors; comparative cost of insulation of single and polyphase motors; single-phase motors on polyphase generators; single-phase motors for lighting circuits; single-phase motors for high frequencies; the desirability of motor load for central stations; the special value of motor load to small stations; the day circuit as a factor in the building up of small towns, and power rates for single-phase motor service. The discussion of the subject was based upon the assumptions that the single-phase motor, except for variable speed work, is to-day the substantial equivalent of the direct-current motor; that polyphase and single-phase types of motors are not competitive, and third, that simplicity of generating equipment and system of distribution are of paramount importance in the profitable development of central station service.

For large plants having polyphase generators, Mr. Layman suggests that the switchboard be arranged for operating polyphase feeders for all large power and rotary converter service, and single-phase feeders for all general lighting service and for all small power work, the switchboard being such that any single-phase feeder may be switched to either phase of the generator buses. Where sub-stations are employed similar switchboard arrangements should be made for polyphase distribution in large units and single-phase distribution for all other kinds of service. Independent feeder regulation should be provided for all polyphase as well as all single-phase feeders. It is stated that the cost of installation of the single-phase motor is much less than that of the polyphase; that satisfactory single-phase motor service can be gotten from polyphase generators, and that single-phase motors can be satisfactorily operated from lighting circuits. The New Jersey Public Service Corporation and the United Gas Improvement Companies are installing single-phase motors up to and including 35 horse-power, and the Cincinnati Gas and Electric Company is adding single-phase motors of 15 or less horse-power capacity and considering larger installations individually on their merits. In Chicago motors of 5 horse-power or less are required to be single-phase and larger installations are considered individually on their merits. Satisfactory single-phase motors can be made for 125 and 133-cycle circuits. There are a number of instances of central stations giving 133-cycle motor service almost up to the maximum capacity of the plant. The paper includes power rates for single-phase motor service as established in Peoria, Ill., and in Cincinnati, Ohio. In the former place the charge varies from 10 cents per kilowatt-hour up to 100 kilowatt-hours per month to 2.8 cents per kilowatt-hour for 2000 kilowatt-hours per month and over, 10 per cent discount being given on all bills paid within ten days. In Cincinnati the basic rate is 10 cents per kilowatt-hour, with discounts varying from 10 per cent for 100 kilowatt-hours per month to 60 per cent for over 800 kilowatt-hours per month, there being an additional discount of 5 per cent on all bills paid within five days.

Mr. J. H. Hallberg stated that the Cincinnati Gas and Electric Company had had to adopt the policy of declining to connect up three-phase motors smaller than 15 horse-power in order to keep down the fixed charges due to the investment for transformers, meters and accessories. They had found that the use of single-phase instead of three-phase motors within the limits mentioned had effected a very considerable economy in fixed charges and had also enabled the company to supply customers whose service would not have been worth obtaining if it had been necessary to run three-phase lines to them and install three-phase transformers, meters, etc. In the case of elevators and other special machinery requiring heavy starting torque, three-phase motors were still used in all sizes.

Wrinkles.

The "Question Box," originated by former President Doherty, has been supplemented by a new department entitled "Wrinkles," which consists of a collection of notes giving an account of practical expedients, home-made apparatus, etc., devised by central station men. The editor, Mr. Charles H. Williams, has been able to collect through correspondence 103 items of this character, occupying 107 pages of the *Transactions*. The character of the matter may be judged from the following titles of some of the notes: Truing engine pins; feed water heater on a gas engine exhaust; a home-made traveling crane; repairing a defective boiler crown sheet; keeping a commutator in good shape without turning or sand-papering; a coil-winding machine; running 9.6-ampere lamps and 6.6-ampere lamps from the same machine; reducing standby losses during light load; transformer testing set for line use; locating breaks in series arc circuits; water rheostat used as a starting box; a special transformer for thawing frozen water pipes—there being several notes on this subject; a novel electric sign.

The New Officers.

Some little difficulty was experienced in selecting the new president. Mr. J. W. Lieb, Jr., was in direct line, but it was realized that as incoming president of the American Institute of Electrical Engineers, he had already as much as he could well attend to. Among those favorably discussed were Messrs. Arthur Williams, of New York; J. B. McCall, of Philadelphia, and Alexander Dow, of Detroit. The choice finally fell upon Mr. E. H. Davis, of Williamsport, Pa., who filled with conspicuous ability last year the arduous position of secretary. The other officers elected were as follows: First vice-president, W. H. Blood, Seattle, Wash.; second vice-president, Arthur Williams, New York; secretary, Dudley Farrand, Newark, N. J.; executive committee, Samuel Scovil, Cleveland; A. J. De Camp, Philadelphia; W. F. White, St. Louis.

SMOKELESS BOILER SETTING.

BY A. BEMENT.

Even with a chain grate stoker as usually set under a water-tube boiler, there is a considerable amount of smoke produced from bituminous coal, owing to the gases passing among the boiler tubes before complete mixture of the combustibles in the gas and air can be effected. That combustion may be complete there must be a thorough mixture of the gas and air while still hot; for this to be effected requires that some interval of time exist between the distillation of the gas and its cooling to below the combining temperature. Experience has shown when a chain grate stoker is used that a fire brick arch, or its equivalent, of 14 to 16 feet in length maintains temperature for a period long enough to accomplish the purpose.

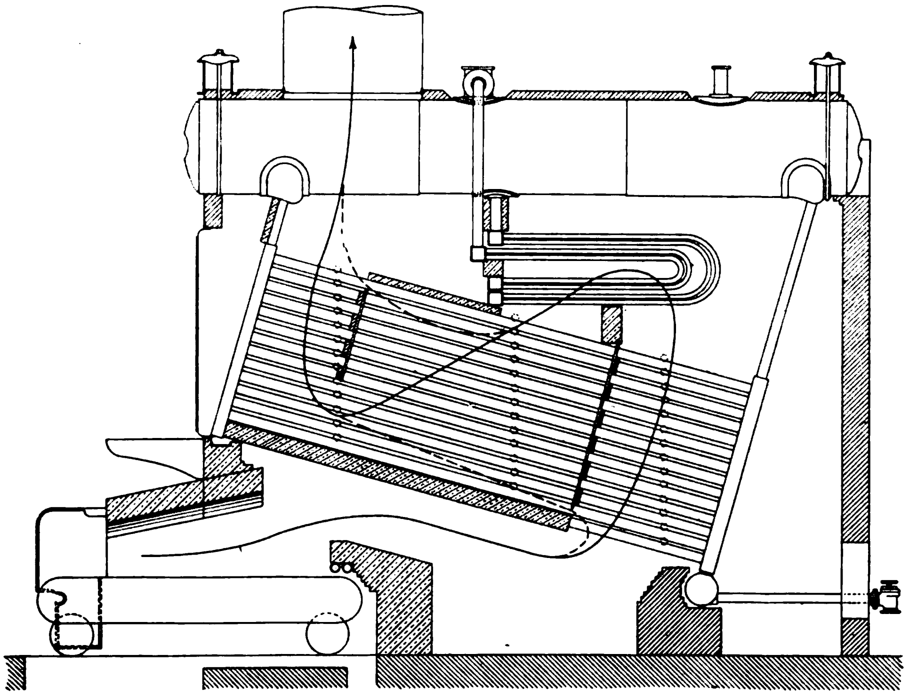


FIG. 1.—BOILER WITH TILE ROOF FURNACE—SHORT GAS TRAVEL.

Some two years ago, the problem of devising a smokeless application of chain grate stokers to Babcock & Wilcox boilers presented itself in an important installation, and it was proposed to suspend tiles from the lower row of tubes as shown in the accompany views, Figs. 1 and 2. This scheme changes the arrangement of the apparatus somewhat. The gases, instead of rising at the front end of the boiler do so at the rear, and in place of leaving at the rear, leave at the front, their path being shown by the arrow. As observed the superheater is reversed in position, but its location is the same as far as exposure to hot gases is concerned. Fig. 1 shows an arrangement of baffles, which allows of the employment in their usual location of the side openings used to blow off the tubes, and Fig. 2 shows an arrangement which causes the gases to flow in contact with a greater amount of boiler surface, which causes an increase in the amount of heat absorbed; as observed, small openings are left at the bottom of the baffles to allow of the exit of dust, also at the top for the purpose of inducing a mild flow of hot gas into what would be dead corners.

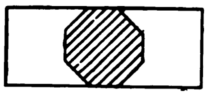


FIG. 3.

Two water-cooled iron pipes are shown under the bridgewall in Fig. 1. Experience has show that this is the best safeguard against careless operators who might feed a serious amount of fire over the end of the grate. The form of bridgewall shown in Fig. 2 is all that is required with a chain grate of proper proportion, provided it is located in a furnace and there is assurance that the fire will not be allowed to feed over the end.

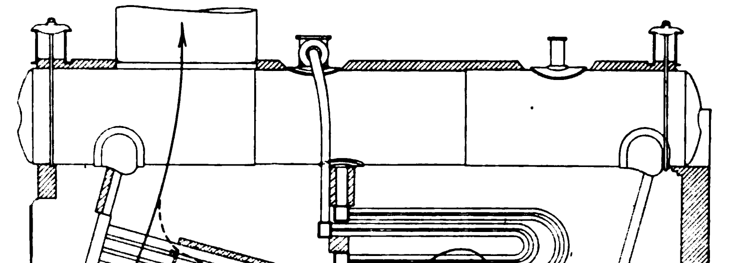


FIG. 2.—BOILER WITH TILE ROOF FURNACE—LONG GAS TRAVEL.

It will be observed that the change in the Babcock & Wilcox setting consists in the application of a furnace, producing a grate, furnace and boiler in place of grate and boiler. The form of tile for the furnace roof which gives best satisfaction is shown in Figs. 3 and 4.

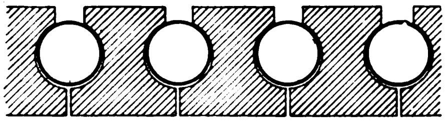


FIG. 4.—SECTION THROUGH TUBES AND TILES.

◆

A THREE-WIRE, 500-VOLT LIGHTING SYSTEM.

BY WALTER I. BARNES.

The first American installation of any magnitude using so-called high-voltage incandescent lamps was made at St. Louis in 1898; owing to certain legal obstructions, however, the St. Louis system was not installed as a pure three-wire arrangement. The first central station to adopt a direct-current, three-wire, high-voltage feeder and main system, with a grounded neutral, was the Narragansett Electric Lighting Company, of Providence, R. I.

The original request of the general manager called for a report on a five-wire system using 125-volt lamps and a three-wire system using 250-volt lamps, and a joint report was presented by Mr. William C. Woodward, the electrical engineer of the Narragansett Electric Lighting Company, and Mr. B. J. Arnold, in May, 1899. The immediate decision of the manager was in favor of the three-wire system. With the 250-volt lamp as a factor in the situation, the alternating-current transformer was no longer a necessary part of the system, for wherever a 500-volt, two-wire system could be operated to advantage, it was possible to modify the arrangement so as to allow of the use of a three-wire, 250-500-volt system.

In 1899 the Narragansett Electric Lighting Company had a connected load of 9000 kilowatts, of which 4900 kilowatts was in alternating-current, multiple distribution, 2700 kilowatts in direct-current, 500-volt motors, 400 kilowatts in commercial series arc lamps, and 1000 kilowatts in series arc lamps on city contracts. The electrical generating equipment consisted of three 500-kw., alternating-current, 60-cycle generators, three 500-kw., direct-current, 500-volt generators, 16 Thomson-Houston series generators of 50 lights capacity each, and 18 Fort Wayne series generators of 125 lights capacity each.

A city ordinance relating to overhead wires required that all overhead construction of the Narragansett Electric Lighting Company within the close fire district of the city should be removed within three years from the passage of the act. This necessitated the removal of 600 poles and about 160 miles of wire in any event, and the company, for the benefit of the service, voluntarily increased the area of territory about 100 per cent.

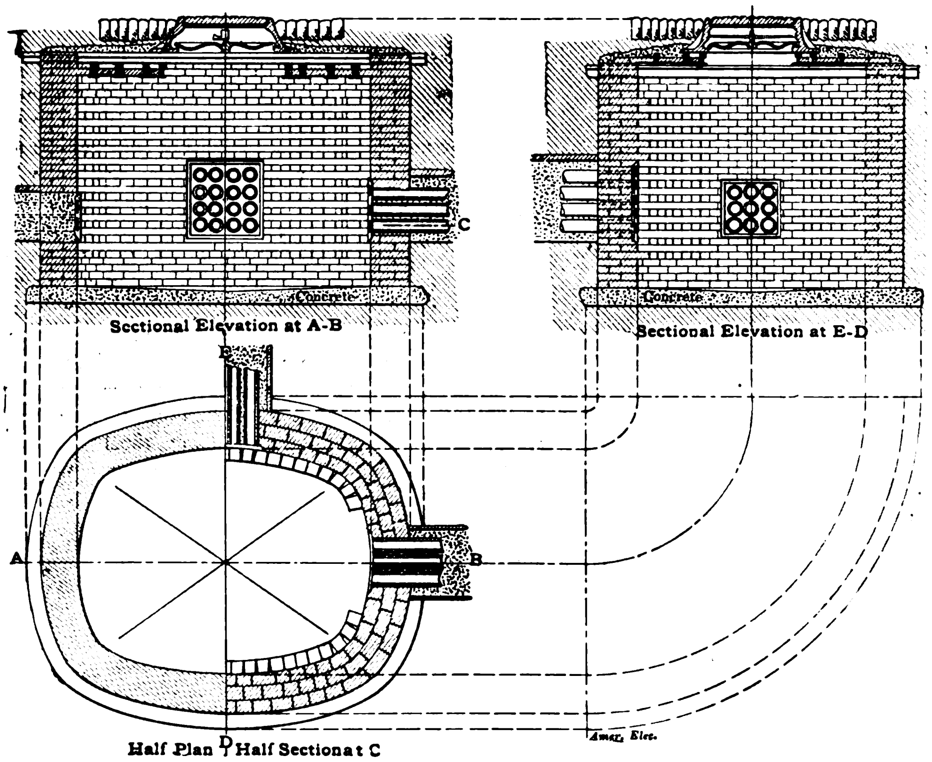

Concrete
Sectional Elevation at A-B
C
E
Concrete
Sectional Elevation at E-D
A
B
D
Half Plan Half Section at C
Amer. Elec.

FIG. 1.—GENERAL CONSTRUCTION OF MANHOLE.

In general, the proposed reconstruction provided for the construction of a complete underground system, an installation of a storage battery, the discontinuance of the alternating-current system in the close fire district and some adjacent territory, the discontinuance of the commercial series generators, and the removal of the poles and wires as required by the ordinance. The construction of the conduit system was begun in October, 1898, and continued until December, 1901, during which time about 40 miles of streets were opened and 1,700,000 feet of ducts were laid. Of this amount about 1,000,000 feet are single-duct and 700,000 multiple-duct. There were built about 850 manholes of an average size of six feet square and seven feet deep. The general construction of the manhole is shown in Fig. 1. The ducts that were used in the underground system were laid on a three-inch bed of concrete, which was spread on a spruce board bottom; the side walls beyond the ducts were of concrete three inches thick and well rammed between the side boarding and the ducts. Over the ducts was a three-inch layer of concrete, above which was placed a protective layer of creosoted plank an inch and a half thick. After laying, the ducts were all rodded and cleaned, ready for drawing in of cable.

Owing to the peculiar location of the streets along the river front, the conduit system was often below tide level, and it became necessary to waterproof the system of conduits and manholes where they were close to the water front. This was accomplished by building 12-inch side walls on the concrete bottom of the trench, and covering the side walls and concrete with several layers of tar paper laid in hot asphalt. The waterproofing of the manholes was accomplished in a similar manner, and the results indicate that such a method is perfectly satisfactory.

Into this system of ducts there was drawn about 2,000,000 feet of cable, varying in size from No. 14 B. & S. gauge, used as potential wires, to cables having an area of 1,000,000 circular mils, used as tie lines between generating and battery stations. Rubber-covered cable only was used, the insulation being Okonite, varying in thickness from 5-32 to 9-32 inch, according to purpose for which it was intended. The thinnest insulation was used in the three-wire system. For the alternating-current, 2200-volt system, and in the constant-current, 6050-volt system, the insulation is 7-32 inch thick, and in the 11,000-volt transmission circuits the thickness of insulation is 9-32 inch. It is worthy of note that in five years of continuous operation not a single fault has developed in the cable or conduit system.

In the direct-current system, the main conductors have an area of 200,000 and 300,000 circular mils, according to the district in which they are situated. The feeders vary in area from 200,000 to 500,000 circular mils, according to length and load. There are 33 feeder points in the direct-current system, and the connected load at present is about 9000 kilowatts, of which 4000 kilowatts consist of stationary motors varying in capacity from 0.25 kilowatt to 75 kilowatts. The remainder of the load consists of 80,300 incandescent lamps and 1280 arc lamps. The incandescent lamps average 3.3 watts per candle-power, and have a useful candle-hour area of not less than 4000 hours, assuming the smashing point to be at 80 per cent of the initial candle-power.

The arc lamps in use at present are of the twin-carbon enclosed-arc type, and operate in multiple on 250-volt circuits—that is, two arcs in a single inner globe—the current averaging 2.3 amperes and the energy per lamp averaging about 575 watts; the two arcs are in series. This lamp has proved quite satisfactory, and is much to be preferred to the single-carbon lamp with about 160 volts at the arc.

For the purpose of producing the best possible regulation and also to tide over the peak load, a storage battery was installed at a sub-station about 2400 feet from the generating station, in a location which in time will be fairly in the centre of the distributing system. The battery consists of 296 cells of 43 plates each, and has an eight-hour discharge rate of 840 amperes. The cells are mounted on an insulating system which has served to obviate the various troubles often found in battery insulation. A double tier of porcelain insulators is used; the first tier is mounted on four brick piers, which are capped with a hard-pressed tile thoroughly impregnated by boiling in paraffin; triple-petticoat porcelain insulators are then placed on the tile. Longitudinally with the cell and resting on the four insulators are placed two hard-pine sticks, four inches by four and three-quarter inches, well painted with an acid-proof paint. On each of these sticks are placed three tiles boiled in paraffin, and resting on these tiles is a second tier of porcelain insulators; these support the battery tanks.

The distance from the floor to the bottom of the tank in 20¾ inches. The floor under each cell is pitched from a point under middle of cell to the aisle between the cells at an angle of about 20 degrees. This allows any surface water or drippings from the tank to drain off rapidly. Frequent washings of the floor immediately under the tanks and systematic cleaning of the insulators that may be conveniently and safely reached. have served to produce the best results in practice, the leakage to earth being entirely eliminated.

The battery is seldom discharged in regular service above the three-hour rate, and then only for a period of about an hour. The load on the system is so nearly balanced that the unbalanced condition seldom exceeds 3 per cent of the load, and the neutral conductor is of ample capacity, even should the unbalancing greatly exceed the figure given. In order, however, that the battery may be always in balance as near as possible, a balancer generator is to be installed.

As the 250-500-volt three-wire system was a radical departure from all standards then existing, every precaution was taken to obtain the best and safest results. It was decided to re-wire most of the older installations, and although in many instances the wiring in customers' premises required but slight modification, yet there were other cases where the entire wiring equipment was replaced.

Certain types of fittings were adopted as standards, so that the installations might be uniform throughout the entire territory. The Edison type of fibre-lined socket with a mica disc under the centre contact was adopted. Enclosed fuses of the plug and cartridge type were used to replace open-link forms. Modern switches took the place of older patterns, and iron or steel pipe was generally used to replace wooden moulding.

There was naturally a great saving in the amount of copper used in the new system. In re-wiring some old installations it was not unusual to find two or perhaps three No. 0000 wires in each side of the mains, run in a heavy moulding from transformer to centre of distribution, the installation having been made in the old days of 4.5-watt, 50-volt lamps. These conditions were in marked contrast to the small iron pipe run from manhole to centre of distribution, containing three No. 10 wires which supplied the same amount of power. Aside from the very material view of the investment saving under the new arrangement, there is the æsthetic viewpoint, which is much better satisfied in the improved construction made possible by the features of the present system.

The several sections of the city that were included in the changes were served with about 50,000 incandescent lamps, 1000 arc lamps and 2000 kilowatts in stationary motors, and these installations were reconstructed to comply with the requiremnts of the new system. The changes from aerial to underground supply, and from alternating-current to direct-current service, were made without any interference with the customers.

The commercial series arc lamps being replaced by multiple arc lamps of the new type, the series generators were released from service at the central station. The arc lamp situation was at first rather perplexing, as none of the larger manufacturers were inclined to provide such a lamp as was demanded. A lamp manufacturer finally produced a lamp that was the forerunner of those now generally used.

All motors of the direct-current type are connected to the outside or 500-volt wires, and although these motors operate devices that are subject to wide and sudden changes in load, the lighting service is not effected by the disturbances of load condition.

In a central station already operating a two-wire 500-volt motor system, the addition of a third wire is all that is necessary to obtain an efficient and a flexible wiring system for lighting purposes. The fact, too, that the same generating apparatus may be used for both motor and lighting service is no small factor in the situation, the natural motor load being a day load, while the lighting load, generally extending well into the night, serves to produce a very satisfactory load curve, particularly if a properly proportioned storage battery forms part of the equipment. The direct-current load curve of the Narragansett Electric Lighting Company is of such a character that during 17 hours out of the 24 a 2000-kw. unit could be operated under advantageous conditions.

The management of the Narragansett Electric Lighting Company, realizing that the public was to be given every consideration in the matter of protection, laid the plan of the proposed system before recognized authorities on fire hazards, and received their approval for the undertaking of the work. The personal risk was also fully discussed, and it was decided that there was no objection to the installation of the system described when accident to person was considered. Vindication of this decision is found in the fact that during five years of operation there has not been a single fire loss or personal injury for which this system was responsible.

The author personally favors the general use of a neutral conductor, which is continuous from source of supply to point of use, and is thoroughly grounded at every possible point inside the customers' premises, and certainly in the network of mains and feeders in the streets. Then the use of single-pole switches on the positive and negative sides of the system is a sufficient means of opening any branch circuit. A typical installation embodying these ideas is the wiring system in the Union Trust Company Building at Providence. In this building the neutral consists of a continuous copper conductor from the street mains to the top floor of the building, which is twelve stories high. At each floor there is a centre of distribution for that floor, these centres being supplied by one of the four-feeder circuits from a main distributing board in the basement—each feeder circuit supplying three floors. All tap circuits are single-wire, the pipe system and frame of building being used as a neutral conductor for the branches. The ends of the pipe system at centres of distribution are bonded together and to the copper neutral riser. Single-pole switches and cartridge fuses are used in the branch circuits.

In connection with this installation it may be noted that the space required for the positive and negative feeders in the wire shaft is only 3 ins. x 9 ins., each feeder being installed in an iron pipe. Comparison of this space with what would be required if a 110-volt system were used, will give some idea of the practical economy in operating at the higher voltage. The installation just cited is but an instance of the use of the intentionally grounded neutral—the whole system being planned on similar lines; in some instances, where it was found advisable, bare copper is used in the neutral branches.

All previous references in this paper have applied to the direct-current system, but the Narragansett Electric Lighting Company has proved to its satisfaction that the same general methods may as well be used on alternating-current systems. The direct-current system having been well established on the lines indicated in this paper, changes are now in progress which in a few months will place all alternating-current service on a three-wire system of 250-500-volt secondary mains with grounded neutral. Several sections of the city outside the direct-current district have already been remodeled with results that confirm the calculations. When the changes shall have been finally accomplished the entire incandescent lamp business of the company, amounting to about 185,000 lamps on a 16-c.p. basis, will be operated at 250 volts, and all motors, both direct-current and alternating-current, will be of standard 500-volt types.

[The foregoing is an abstract of a paper read before the Boston convention of the National Electric Light Association.]

TABLE OF SIZES OF SERVICE LATERALS.

Narragansett Electric Lighting Co.'s 250-500 Volt System.

	Three-wire Lighting—Distances in Feet.						H.P. of Motors.	Two-wire Motors—Distances in feet.				
Amp.		10	20	30	40	50		10	20	30	40	50
10	Calculations are based on.	No. 10	10	10	10	10	1 to 5	No. 10	10	10	10	10
15	.224 amp per 16-c.p. lamp.	No. 10	10	10	8	8	6 to 10	No. 10	10	8	8	8
20	at 250 v. or 8.94 lamps..	No. 10	10	8	8	8	11 to 15	No. 6	6	6	4	4
25	per amp. on outside of 3..	No. 8	8	6	6	6	16 to 25	No. 4	4	0	0	0
30	wire system at 500 v...	No. 6	6	6	4	4	26 to 50	No. 0	0	0	0	0
35		No. 6	6	4	4	4	51 to 75	150,000	150,000	150,000	150,000	150,000
40		No. 6	6	4	4	4	76 to 100	200,000	200,000	200,000	200,000	200,000
45		No. 4	4	0	0	0						
50		No. 4	4	0	0	0						
75		No. 0	0	0	0	0						
100		No. 0	0	0	0	0						
150		No. 0	0	0	0	0						
200	300,000 circ. mils. for all laterals up to 75 feet.											

Distances given are from mains to service box.

Wire sizes in B. & S. gauge and circular mils. All conductors larger than No. 6 are stranded. Insulation, Okonite 5/32 in. wall, 1/10 in. lead.

Breakdown strain 10,000 volts alternating current.

Abstracts from Foreign Contemporaries

Humming of Dynamos.—In a recent number of the *Zeitschrift für Elektrotechnik,* J. Fischer-Hinnen deals with the causes and the remedies for the humming of dynamos. This phenomenon appears to a considerable extent only in machines with laminated poles and a small number of slots per pole, six to nine, and increases generally as the air-gap increases. By means of tuning forks of known frequencies, the author determined the note given off by various machines, and it was found that these agreed in every case with the number of armature teeth that passed a given point in a second. The inference was therefore that the sound is produced in the laminated poles by the variation of the flux due to the teeth, and it is evident that the strength of the hum increases with diminishing numbers of teeth per pole. As a result of a number of tests, the author has found that if the equation $\frac{b - 0.7r}{(D + 2\delta)\pi} N =$ a whole number + 0.5 be fulfilled, then humming will not occur at all or only to a small extent. In this equation, b = peripheral width of pole shoe, r = radius of the rounded-off portion of the pole top, D = diameter of armature, δ = air gap, and N = number of slots. Although the above equation was correct with regard to the machines tested, the author does not put it forward as reliable in all cases, since it does not take into account the slot width.

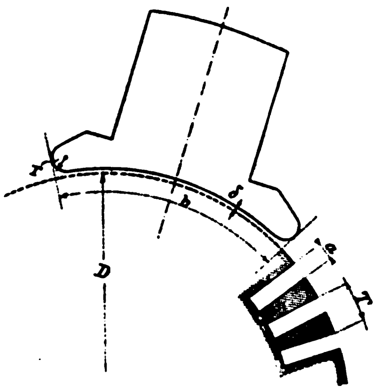


FIG. I.—HUMMING OF DYNAMOS.

Melhuish's Internal-Combustion Engine.—In the operation of the internal-combustion engine of A. G. Melhuish, which is described in the London *Mechanical Engineer,* the suction valves are worked automatically without the use of side or lay-shaft gearing cams, levers, etc., while an arrangement is provided whereby the exhaust gases are completely silenced. The engine, which works on the four-stroke cycle, is shown in Fig. 2. It comprises a duplex piston *A B* of differential areas, the front or larger end *B* being of such diameter as to be a little more than double the area of the smaller or working piston *A*. The differential piston works in the cylinders *C D*, and at a position corresponding to the piston's complete outstroke a port *E* is formed leading into a condenser chamber *F*. This condenser *F* is also in communication with the front or larger cylinder by the port *G*. The inlet air and gas valve *H* is provided to the working cylinder. A valve *I* opening outward is provided to the condenser *F*. The engine works as follows: A charge is compressed and fired. This expands and forces out the pistons, *A B* doing work, at the same time a partial vacuum being created in the condenser *F* and front or larger cylinder *D*. At the completion of the outstroke the pressure remaining in the working cylinder *C* passes through the port *E* into the condenser *F*, the partial vacuum within entirely silencing the noise by reason of its rapid expansion in a void. The second or instroke now commences, and displaces the products from the vacuum cylinder *D* and condenser *F* through the non-return valve *I*, and the products remaining in the working cylinder are compressed. The third or outstroke now commences, the products re-expanding, and a vacuum being again formed in the condenser *F* and large cylinder *D*. As soon as the piston reaches its outstroke limit, the air and gas inlet valve *H* is opened by reason of the vacuum and this vacuum is satisfied by the inrush of a new charge into the working cylinder *C*, the old products being withdrawn into the condenser *F*. The fourth or instroke compresses the new charge and empties the condenser for the cycle to commence again.

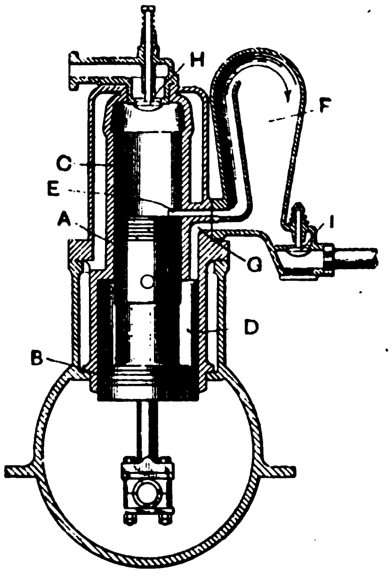


FIG. 2.—MELHUISH INTERNAL-COMBUSTION ENGINE.

Exhaust Valve Control for Gas Engines.—The controlling mechanism for the exhaust or release valves of internal-combustion engines shown by Fig. 3 is described in a recent issue of *The Mechanical Engineer* of London. The mechanism is especially applicable to motors governed by varying the quantity of explosive mixture drawn in by suction. The exhaust valve *A* is operated by two levers *B* and *C,* acting through the intervention of rolling surfaces so as to decrease the power necessary to move the valve from its seat. One of the levers *C* is operated by the rod *D* of an eccentric *E* keyed on the valve gear shaft *F* so that the motion of the valve is invariable with that of the engine piston. The exhaust valve opens with a suitable lead and closes toward the end of the stroke which expels the burned gases. One part only of the stroke of the eccentric *E* is used to operate the valve, the remaining part of the eccentric's stroke being utilized to increase the tension of the valve closing spring *G* during the engine piston's suction stroke which follows the stroke which expels the burned gases. The maximum compression of the exhaust valve spring takes place at about the end of the suction stroke. By this arrangement the exhaust valve *A* is relieved of part of the pressure of the valve closing spring *G* at the moment it begins to rise, the tension of this spring remaining constant the whole of the time the valve is being lifted. It is possible to give the valve spring *G* sufficient tension to prevent the valve being unseated by the action of excessive vacuum in the cylinder.

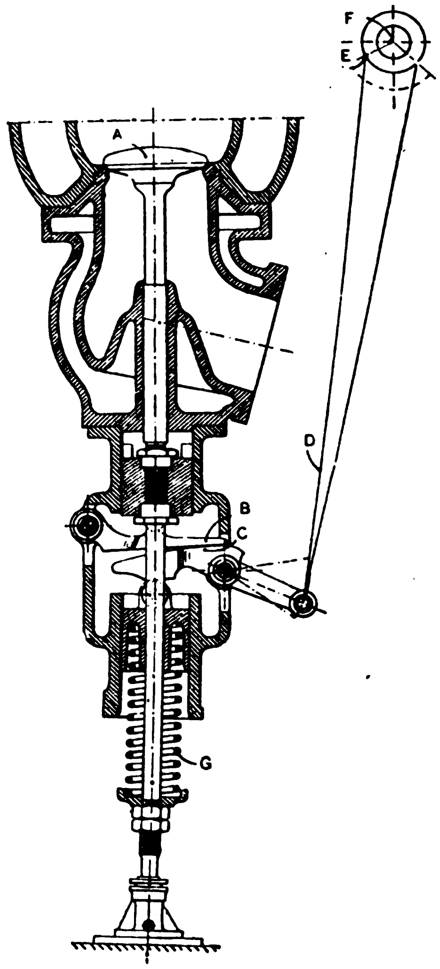


FIG. 3.—EXHAUST VALVE CONTROL OF GAS ENGINES.

Lancashire Reversible Booster.—Two boosters have been included among the recent extensions to the Derby Electric Works and Tramways which are described in a recent issue of the London *Electrician.* One is an ordinary shunt-wound reversible motor-driven booster for charging and discharging the cells on the lighting mains, and can deal normally with a current of 100 amperes, raising the pressure by 70 volts, and will deal with 200 amperes for one hour. The traction booster offers several interesting features, however; it is an automatic reversible booster and provision has been made with considerable ingenuity for almost every possible contingency. It is constructed under the Turnbull and McLeod patents. In external appearance this latter machine is merely a four-pole dynamo driven by a four-pole motor; but, while the motor is nothing more than a shunt motor, the booster itself has four field windings (see Fig. 4). One of these (*A*) is a shunt winding across the booster terminals, excited by the difference of potential between the battery and the bus bars. *B* is an auxiliary shunt winding, which the makers call the "potentiometer shunt," connected straight across the bus bars. *C* is a series coil between the negative dynamo terminal and the negative main, and *D* is a series coil of a few turns in series with the armature of the booster itself. The object of the reversible booster is, of course, to keep the load on the dynamos practically constant, the battery discharging when the load rises above the normal and charging when it becomes less than the normal. Taking into account the large variations in the voltage of a battery (not only with varying current but with the same current at different times), it is evident that the first requisite is an exciting coil which shall always make the sum of the battery and booster voltages practically equal at all times to the bus-bar voltage. This is accomplished by putting on the coil *A*, excited by the difference between the battery and bus-bar voltage. If the booster is worked on the straight part of the characteristic, it will be seen that this coil can be made to give a voltage on the booster armature always equal to the difference between the battery and dynamo voltage; also a very slight increase or decrease in the excitation will cause the battery to charge or discharge. The second shunt coil, *B*, across the bus bars tends to increase the voltage on the booster, which, again, would increase the effect of coil *A* and the battery would charge heavily; as however *B* is opposed by *C*, which is a series coil in the dynamo circuit, the arrangement is stable when the current in *C* is such that its magnetizing effect just balances that of coil *B;* and as *B* is a constant shunt coil, the current in *C* must always be constant, which is what is required. The series turns *D* added in the battery or feeder circuit make up for the armature reaction and drop of the booster itself. If the dynamo tried to take an overload, the coil *C* would overpower *B* and the battery discharge until equilibrium was restored; on the other hand, if the dynamo current tries to reduce on light load, coil *B* overpowers *C* and the battery charges until they are balanced. The makers point out that, as the booster depends for its control on the dynamo current, and not on any balancing of voltage depending on the dynamo characteristic, compound machines can be used as well as shunt, and all trouble from shunting and kindred causes is avoided. Most boosters which do not depend on the falling characteristic of a shunt dynamo rely on the drop in volts on the battery and booster in discharging, which is balanced by a series coil in the feeder; if that coil is not exactly of the right strength, the battery discharges too much or too little, usually varying with the state of the battery. The particularly valuable property of a coil in the dynamo circuit consists in the fact that it can be made as strong as desired and always balanced by a regulator on the shunt coil to fix the dynamo current at anything required, and if the current should vary acts with very great force to bring it back to the normal again, thus making the booster very stable and greatly facilitating paralleling. If it is desired to use the battery and the booster on the line without the generators, coil *A* is disconnected and coil *C* connected to help coil *B*, giving the battery a constant voltage with varying load. The field magnets are laminated throughout, including the yoke, giving the quick reversal so necessary for traction work. The booster is designed for a working current of 200 amperes normal and 300 amperes for 1 hour, and to supply 70 volts for prolonged periods and 120 volts as a maximum. The machine runs normally at 800 r.p.m.

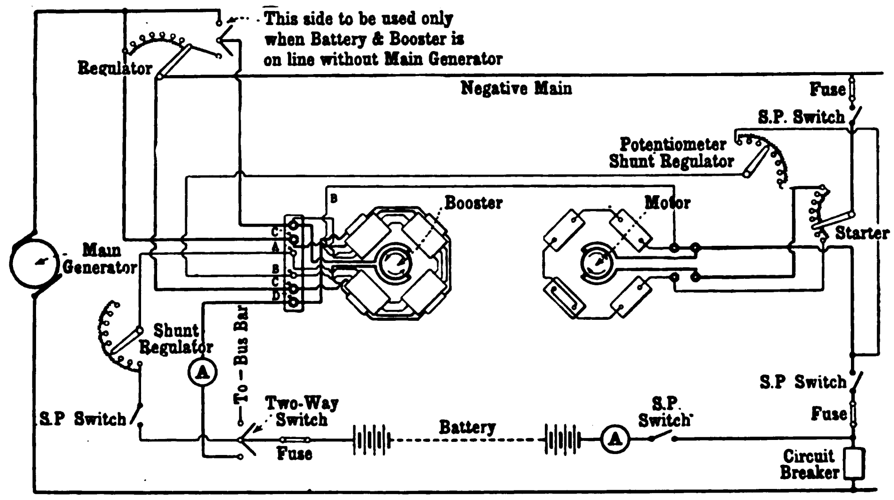


FIG. 4.—DIAGRAM OF CONNECTIONS, LANCASHI RE REVERSIBLE BOOSTER.

Automatic Cut-off Gear for Internal Combustion Engines.—*The Mechanical Engineer* of London describes an automatic cut-off gear for internal-combustion engines by means of which variable impulses are given to suit the load. The gear, which is shown in Figs. 5 and 6, comprises a small cylinder formed inside the casing *A* of the valve *B* which controls the admission of gas and air to the power cylinder of the internal-combustion engine, and inside this small cylinder is fitted a sliding cut-off valve *C* in the form of a sleeve with a piston head. This valve *C* has a series of ports *D*, and the admission valve casing *A* has corresponding ports *E* and *F*, the ports *E* leading from the air supply passage *G* and the ports *F* from the gas supply passage *H*, so that when the ports correspond with each other in position, as shown, and the admission valve *B* is open, there is free passage for gas and air from the supply passages into the power cylinder, but a small endwise movement of the sliding cut-off valve *C* will close, or partially close, the ports *D, E* and *F*, and so cut off admission to the power cylinder. The admission valve *B* is held normally closed by a spring *I*, and the cut-off valve *C* is held normally open by two springs *J*. By the springs *J* the piston head of the cut-off valve *C* is held close up to the end of its cylinder, so as to leave as little clearance

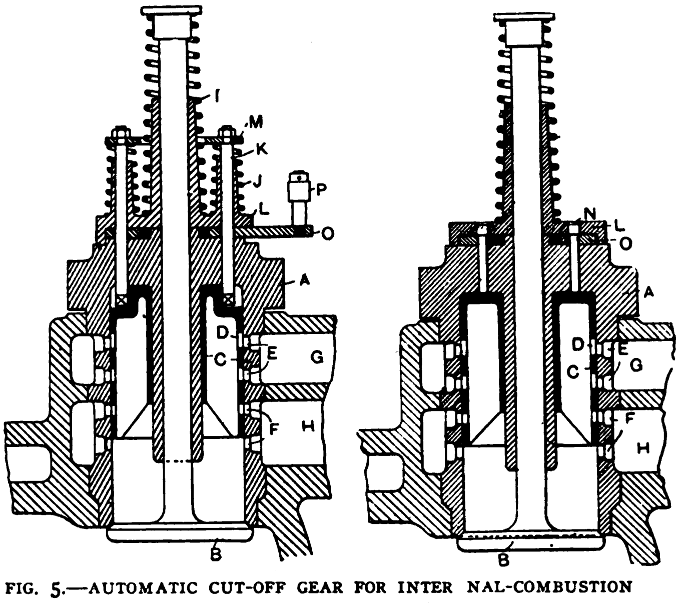


FIG. 5.—AUTOMATIC CUT-OFF GEAR FOR INTER NAL-COMBUSTION ENGINES.—FIG. 6.

space as possible. Communicating with the closed end of the cut-off valve cylinder are a number of small air holes *N* in the cover *L* and casing *A*, and these holes *N* are closed or more or less opened by an oscillating regulating plate *O*. The regulating plate *O*, which oscillates on the admission valve spindle as its centre of movement, has holes in it corresponding to the holes *N*, and it is actuated by a connecting rod *P* connected to the governor. When the governor, by means of the connecting rod *P*, moves the regulating plate *O* so as to close the holes *N*, no air can obtain admission to the end of the small cylinder at the back of the cut-off valve piston head, and therefore, although the suction on the other side of the piston head, due to the movement of the main piston of the engine making a suction stroke, tends to move the piston head with its cut-off valve *C*, it cannot move, being held back by vacuum, and consequently a full working charge of gas and air is drawn through the open ports *D, E* and *F*, into the power cylinder, and full working impulse of the main piston will follow. When, however, the governor moves the regulating plate *O* so as to open the holes *N* to the atmosphere and admit air to the back of the cut-off valve piston head, the suction of the main piston will cause the piston head with its cut-off valve *C* to move during the suction stroke of the main piston, earlier or later, according to the extent to which the holes *N* are opened by the regulating plate *O* as determined by the governor. The earlier or later movement of the cut-off valve *C* will decide the point at which the gas and air admission is cut off during the suction stroke, as well as the volume of charge drawn in and the power developed by the following impulses, which are thus controlled by the governor.

New Single-Phase Motor.— An interesting patent for improvements in single-phase motors granted to Crompton & Co. and R. Goldschmidt has just been published in the London *Electrician*. The inventors claim to have obtained a better starting torque, and without the use of a commutator. The invention is based on the well-known law, in accordance with which a closed coil of conducting material placed in an alternating magnetic field will set itself in such a position as to enclose the smallest possible number of lines of magnetic force. A closed coil, *C* (Fig. 7), suspended, pivoted or mounted on an axle within a two-pole magnetic field, *FF*, excited by an alternating current in the coils, *SS*, so that its plane makes an angle with the direction of the lines of force, will have a current induced in it and a force exerted upon it tending to set it with its plane parallel to the lines of force. When the coil is moved into this position the inductive action ceases and the current in the coil falls to zero. In order to obtain continuous rotation, the circuit of the coil is automatically broken as the plane of the coil lies parallel to the lines of magnetic force, by means of a collector ring consisting of two segments, *PP*, to which the two ends of the coil are connected and which rotate with the coil. In the case of a coil placed in a two-pole magnetic field each segment should subtend an angle of about 90°. Two brushes, *BB*, connected together electrically, either directly through the lead *L*, or through resistances, choking coils or condensers, and placed at opposite ends of a diameter, must be provided and fixed so as to rub on the two segments of the collector ring. These brushes must be so placed, and the exact angle subtended by the segments of the collector ring must be such that the coil *C* will be short-circuited, or partially short-circuited, by the brushes *BB* while passing through any two opposite quadrants of a circle, and will be on open circuit while passing through the other two quadrants. If sufficient momentum is provided in the revolving coil itself, or parts attached to it, to carry it through that part of the revolution in which it is on open circuit, such an apparatus will constitute a simple form of single-phase, alternate-current motor. In order to avoid the disturbing effect of the armature reaction the poles of the field magnet may be split, in the middle, or a short-circuited winding be inserted in them. In order to be independent of momentum for obtaining continuous rotation, and in order to avoid all electrical and mechanical irregularities, the inventors prefer to employ several rotating windings, or coils, instead of one. These coils would be situated equidistant from one another, and the segments of their collector rings and the brushes belonging thereto would be so situated, relatively to one another and to the coils, that the coils become short-circuited or partially short-circuited as soon as they enter under the poles of the magnet, and are open-circuited again as soon as they pass the centre point of the poles of the magnet.

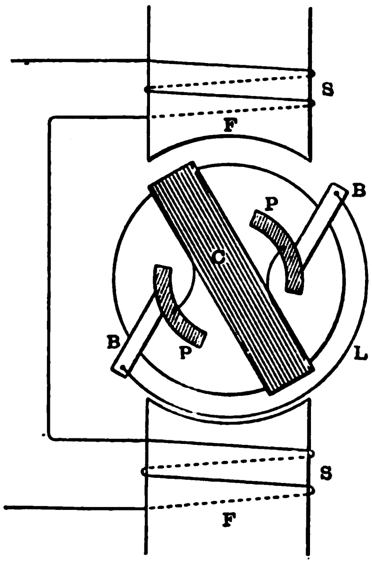


FIG. 7.—SINGLE-PHASE MOTOR.

Automatic Reversible Booster. — In an illustrated description of the Leicester Corporation Electric Tramway published in the London *Electrician* an account is given of an automatic reversible booster which combines many interesting features. One of the main features of this system is the use of the Thury automatic pressure regulator for automatically maintaining a constant load on the generators running in parallel with the battery. The booster armatures are drum-wound, with a slightly channeled core, and the coils are held in by driving horns. A double-wound armature is employed, and each winding is connected to a commutator, one at each end of the machine. The two armature coils can be connected in series or parallel as required. In the design of the reversible booster special attention has been paid to meeting rapid changes of load and voltage without sparking. With these armatures the winding on the smooth core is placed as near as possible to the periphery, and with the tangentially arranged field coil the iron in the field magnets is reduced to a minimum. The combined efficiency of the reversible booster set is 81 per cent. After a six hours' run at full load, the temperature rise does not exceed 70° F. Fig. 8 is a diagram of connections of the Thury system.

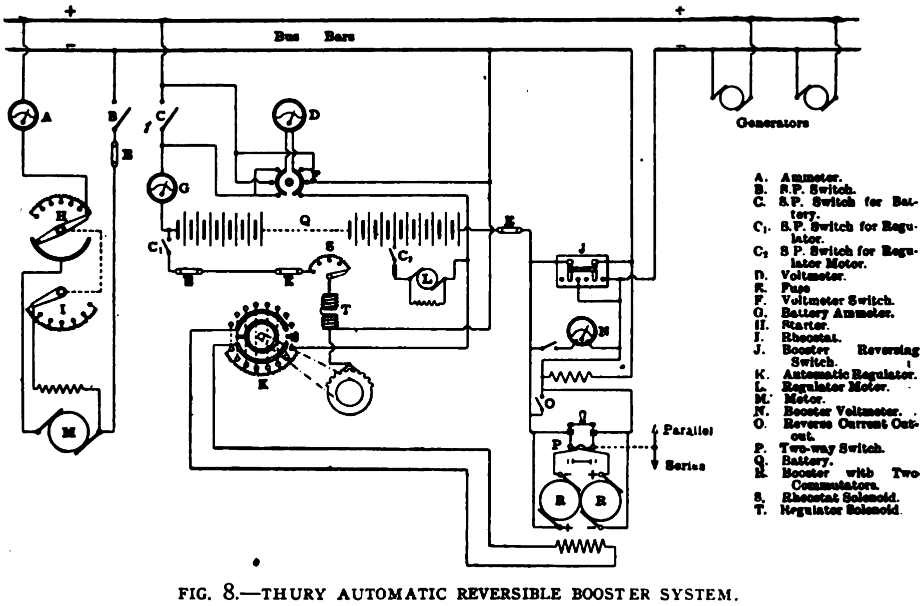


FIG. 8.—THURY AUTOMATIC REVERSIBLE BOOSTER SYSTEM.

The Patent Situation.

To the Editor, American Electrician:

In your June issue I note an editorial (page 293) in which among some wise remarks you make concerning the United States patent system, you also incidentally make some strictures thereon which seem very unfair, and which you ought to be willing to have further discussed. The opening statement that the "patent situation" either excites mirth or disgust, seems to me a little extreme, and the following statement to the effect that the actual value of a patent is usually *nil* until it has been litigated in the courts, is certainly erroneous. Statistics show that something like 90 per cent of the industry of the United States is based upon inventions which are or have been patented. There have been issued something over 760,000 patents, and the courts have from the beginning to this date had before them, for consideration in any way, less than seven thousand patents. It follows, therefore, either that many patents are good without litigation, or else that only 1 per cent of the patents issued have been of any value. That a business can be built up upon a patented invention when the patent "excites ribald mirth" seems absurd; yet the basis of practically the entire industrial property of this country is found in the value of patented inventions. From the lawyer's standpoint it may be remarked that the litigation is not caused by the patent system nor by the conduct of attorneys, but by the refusal of other men to obey the dictates of law and good conscience. As to the rejection of applications it would seem that the opinion of a bureau consisting of the most uniformly well trained body of men in charge of any government business in the world, ought to prevail against that of a possibly ill-advised critic. But if you say in one paragraph that patents are improperly rejected, it seems a trifle inconsistent to say in the following paragraph that "the most serious feature is the ease with which worthless patents may be obtained." At any rate, a patent "issued without justification" is a nullity, and need not restrict anybody who is informed, while the records and all the patents are easily accessible to public scrutiny, just as the courts are open to all who are aggrieved.

The feature of the American patent law system which is most remarkable and most salutory, and which is nevertheless most widely misunderstood, is this; that the government undertakes to protect an inventor in monopolizing what he has created for a limited period, in return for his thereafter freely giving it to the public, and meanwhile the temporary monopoly can neither accrue to the benefit of the inventor nor in any wise deprive the public of anything unless the invention proves to be a thing of value to the public. That is to say, if the public wants to use the invention, it is proof that the invention is valuable to the public; whereas if the invention is not valuable, the inventor gets no benefit whatever from his monopoly. Or, if a slang phrase may be excused, the system is such that the public pays nothing and the inventor gets nothing unless the inventor first delivers the goods.

The meat in the cocoanut is contained in the editor's sensible recommendation that inventors should at last awake to a consciousness of the fact that a patent is a charter of the inventor's rights and the drawing up of the charter should be entrusted to trustworthy people. If it is true that the liberality of the Patent Office admits of unscrupulous attorneys preying upon the credulous inventor, then, since the Patent Office evidently cannot make distinctions between attorneys, it follows that either the office would have to amend its policy to the detriment of all inventors, or else the public must itself undertake the duty of suppressing unreliable attorneys.

Pittsburg, Pa. F. W. H. CLAY.

[We are always willing and glad to have our statements discussed fairly. General statistics, however, prove very little, and an array of them is seldom the equivalent of argument. The fact that the courts have had to pass upon less than 7000 out of a total of 760,000 patents merely indicates, in our opinion, that most of the patents issued were not worth litigation. We think a contemplation of the Patent Office Gazette will support this hypothesis admirably. However, we explicitly modified our statement as to the value of a patent to apply to "at least the large majority of electrical patents." We will be very glad for Mr. Clay, or any other reader, to mention a few electrical patents on which industries have been built up without any patent litigation.

We had no intention to criticise the Patent Office examiners; the inconsistent results referred to are not due to their inability, but to conflicting court decisions which make life a burden to the examiners.

It is the absolute failure of the government to do just what Mr. Clay admits that it undertakes to do that makes the patent situation what it is. Merely giving a patentee the right to prove the status of his patent in court (if he has enough money) falls far short of "protecting an inventor in monopolizing what he has created, for a limited time." If a single tribunal were established at Washington for passing upon the status of patents and establishing consistent precedents, and if infringers were prosecuted (conscientiously) by the government, the patent situation would speedily change for the better. We are perfectly well aware, however, that governmental prosecution of patent infringers is wildly impractical.—EDITOR.]

THE STEAM TURBINE SITUATION.

To the Editor American Electrician:

SIR:—The article entitled "The Steam Turbine Situation," by A. M. Earl, which appeared in your May number, is interesting, although the author manifests a neatly veiled prejudice against the turbine. In asking the privilege of your columns for reply, I realize the futility of mere expression of opinion unsupported by facts; but I believe that Mr. Earl's article tends to create an unfavorable opinion regarding the turbine which it does not deserve. At the risk, therefore, of inciting an argument, I have undertaken to reply at some length upon the more important points brought out.

Mr. Earl has evidently failed to grasp the full significance of the present status of the steam turbine with reference to its principal competitor. I agree with him that "the reciprocating engine has secured its present prominence by sheer force of merit," and its present state of perfection cannot be overlooked. But has not the turbine also reached its present state by force of merit against overwhelming opposition? The reciprocating engine has had a practically clear field from the start; the turbine, on the other hand, entered this field at a time when the engine was as nearly a perfect mechanism as human ingenuity could make it. The engine has practically reached its limit of development; that of the turbine has but just begun. That the former is true is evident from the fact that within recent years the trend of improvement has been entirely along the lines of details in mechanism and construction, rendered necessary by the immense increase in engine capacities.

Mr. Earl states that reciprocating engine practice is returning to its former conservative condition regarding superheat, speed, stage expansions, regulation, etc. This is true, and for the simple reason that these refinements have been found valueless or else they have been productive of slightly higher economy at the expense of some other function. The turbine is, in a measure, controlled by conditions similar to those of the steam engine, although by no means to as great a degree. It embodies the same thermodynamic problem. But its designers have or should have profited by engine builders' experience so that turbine development should be less erratic and founded on less illusive principles.

Any engineer of close observation will, I believe, take issue with Mr. Earl on his statement that "the steam consumption of the turbine is a disappointment," even though compared to the best modern types of steam engines. In order to form a thoroughly unprejudiced opinion of comparative efficiency, it is not sufficient to compare the results from a few tests made under special conditions, calculated to show up the prime mover at its best. These conditions are of scientific interest, but do not tell the average power plant manager what he desires to know; that is, what results he can obtain under the ordinary or poor conditions of his plant. Engine tests are somewhat like good deeds: the best ones are widely heralded, while the ordinary ones, constituting by far the majority, are rarely placed before the public.

On the other hand, there is no lack of data regarding the performance of successful types of steam turbines under every conceivable condition of service. In the accompanying table are given test data most of which have been furnished from the Westinghouse Machine Company's records of certified tests.

These tests reveal the fact that, if operating conditions are provided commensurate with those of the engine, the steam turbine can meet the engine under its best condition. This occurs because the turbine is better able to take advantage of such conditions than the engine. But it is under the moderate working conditions which characterize the average power plant that the turbine excels, and in fact this is its most promising field. European engine builders have striven for economy to the last degree by carrying pressures up to 250 pounds and superheat up to 400° F. Under favorable conditions, a water rate of about 9 pounds per indicated horse-power-hour has been obtained. With normal pressures, vacua, and no superheat, this rate would be more nearly 13 or 14 pounds per indicated horse-power-hour for good engines; equivalent to 17½ to 19 pounds per electrical horse-power-hour.

TESTS OF STEAM TURBINES UNDER VARYING CONDITIONS.

Make.	K.W.	Steam pressure	Inches vacuum.	Deg. F. superheat.	Load % full.	Steam consumption; lbs. per E.H.P.	B.H.P.	*I.H.P.
Brown Boveri Parsons	2600	188	27	214	115	11.02	....	9.38
	2600	188	27.5	180	97	11.57	....	9.84
	2600	186	28.0	186	75	11.83	....	....
Westinghouse								
Parsons	1250	154	28.1	141	121	12.66	....	10.76
Parsons	1250	147	28	102	99	....	12.82	11.85
Parsons	1250	147	28	102	71	....	13.09	....
Parsons	1250	149	28	102	..	....	13.70	....
Parsons	400	148	28	192	106	13.02	....	11.06
Parsons	400	149	28	157	50	15.56	....	....
Parsons	400	150	28	182	129	....	11.17	10.27
Parsons	400	153	28.1	180	100	....	11.46	....
Parsons	1250	146.3	27.1	76	104	13.78	....	11.7
Parsons	1250	151	27.2	77	53	15.9	....	....
Parsons	1250	151.8	27.2	77	15	26.3	....	....
Parsons	1250	146	27.5	28	125	13.67	....	11.6
Parsons	1250	147	27.5	28	61	16.05	....	....
Parsons	400	155	27	97.6	103	13.47	....	11.45
Parsons	400	155	27	103	55	14.54	....	....
				(Quality)				
Parsons	1250	150	26	98%	121	15.72	....	13.35
Parsons	1250	149	25	98%	120	16.32	....	13.9
Parsons	1250	150	25	98%	73	18.82	....	....
Parsons	400	152	26	100%	103	14.59	....	12.4
Parsons	400	125.6	26	25	98	15.41	....	13.1

*Estimated from the assumption of 85% combined efficiency of turbine and generator.

*Estimated from the assumption of 92.5% combined efficiency of turbine alone.

In regard to the statement that "recent tests indicate the probable limit of superheat (of the turbine) not far above the economical limit for the engine," Mr. Earl evidently has the Curtis, Rateau and other forms of multi-cellular turbines in mind. He gives as his reason that "the temperature in the turbine involves larger clearances with decreased economy." He has signally failed in his observations of the Parsons or parallel-flow type of turbine. Axial clearances between moving and stationary blades as high as one inch are employed; not, however, for the purpose of avoiding collision due to differential expansion of rotor and stator, such as occurs in multi-cellular turbines. In the Parsons type, the entire circumference between rotor and stator is occupied by working steam so that an increase in axial clearance does not result in distortion of the velocity diagram by the spreading of the jet during its progress through the various rows of blades in each stage or to the entrainment of the outside steam in the stage chamber. These effects do occur in some turbines of the cellular type and seem to prescribe a smaller running clearance than that desirable for mechanical safety.

Superheat in engines of high expansion ratios is mainly beneficial in reducing cylinder condensation. The advantage to be gained is somewhere near in proportion to the number of expansions. In turbines, cylinder condensation does not have to be dealt with and it is therefore found that, although higher economy may be obtained with higher degrees of superheat, a moderate degree is perhaps more desirable. It is easier to provide for and does not impose such extreme difficulties of maintenance in power station work. The expansion in the turbine is practically adiabatic. If working between 150 pounds pressure and 28 inches vacuum, approximately 23 per cent of moisture would be present in the exhaust. This introduces the element of fluid friction. In turbines employing high surface speeds and correspondingly high steam velocities, it becomes serious. By employing superheat, the point of adiabatic condensation may be deferred to the lower stages of the turbine, and in this manner the fluid friction may be decreased. In the Parsons type of turbine, where low steam velocities are employed, fluid friction is not so important, so that excellent economies are obtained with saturated steam as shown in the table. I know of one turbine plant which operated through cold weather with steam at 100 pounds pressure received through about 250 feet of piping, one-third of which was exposed uncovered to the elements. It was found necessary to install a special pump to keep the exhaust line free from water due to the enormous condensation, but the turbines sustained their load notwithstanding, and at far greater economy than the steam engines which they supplanted.

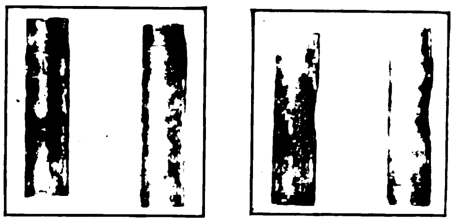
Mr. Earl's statement that "a vacuum of 29 inches is not hard to obtain when the apparatus is new and everything tuned up to 'concert pitch'" requires modification. The vacuum depends largely upon the barometric pressure and the temperature of cooling water. At sea level, a vacuum would be possible that would be out of the question at high altitudes. One station on the Atlantic coast operates the year round on vacuum ranging from 28 to 30 inches and without difficulty, excessive expenditure of power, or extreme care in maintaining the condensing system. At least 25 inland plants are operating on 27-in. and 28-in. vacuum without difficulty; 28 inches may be considered the practical limit with ordinary temperatures of cooling water. The maintenance of this vacuum simply requires good, intelligent work on the part of plant employes. Neither turbine nor engine should be placed in charge of ignorant, untrained labor if good results and high station economies are expected.

Mr. Earl has, I believe, over-estimated the importance of turbine troubles. It is freely admitted by the manufacturers that they have had troubles. Every fully developed machine represents the gradual elimination of defects arising in its predecessors. It is, therefore, hardly logical to condemn a machine on account of real or fancied difficulties simply because these have arisen and have been eliminated. Mr. Earl may have some particular type of turbine in view when he speaks of blades stripping and bearings cutting, mechanical unbalancing, etc. If he had closely investigated the reports from Parsons plants abroad and Westinghouse-Parsons plants in this country, I doubt if he would feel justified in his contention. The troubles which have arisen in the latter have not been kept from those who were legitimately interested; and it is a matter of record that with forty odd units in operation, less than 1 per cent of the blading has shown any indication of trouble from any source. Even this was in no manner due to faulty turbine design, but to distortion of casings by expanding exhaust pipes, and the like.

In no case have the bearings of a Parsons-type turbine been known to heat and cut. This form of turbine is designed with sufficient bearing area to support the weight of the rotating parts without the use of oil under pressure, and the oil is constantly circulated by the turbine itself so that it is impossible for the oil supply to be shut off while the turbine is running. At the least, it can be said upon this point that steam engines also have their troubles; cylinders and valves cut, governors get out of order even to the extent of bursting the flywheel and finally wrecking the engine. All well ordered plants have hose available for submerging hot engine bearings, "mechanical unbalancing creates disturbances" to the extent of requiring massive foundations and holding-down bolts not required for the turbine, wearing parts have to be frequently adjusted, and so on down the list.

The wearing of blades from erosion of steam is frequently advanced as an argument against the turbine. To be sure everything depends on the design, but experience shows that in general the wear does not represent an excessive rate of depreciation on the turbine as a mechanism. Erosion, as in hydraulic work, is practically proportional to the fluid velocities employed, and is aggravated at high velocities by entrained moisture in the steam in the same manner as sand or silt effects a high head Pelton water-wheel. In the simple impulse steam turbine, blade surface velocities as high as 2500 feet per second are encountered, and in some forms of compounded impulse turbines these velocities may be reduced as low as 1500 feet per second. In the Parsons form, however, it has been fortunately possible to reduce the steam velocities to a much lower point—about one-quarter of those occurring in the nozzle type of turbine—with the result that this erosive action is reduced to such a degree as to become entirely negligible.

The difference is strikingly shown in the accompanying illustrations representing the results of experiments under the conditions named. This erosive action may be somewhat reduced in the various impulse types of turbines by evaporating the moisture; which appears to be one of the reasons for the almost universal provision of high superheat in these types. In the several Westinghouse-Parsons plants which have come under my observation, no machines have shown the slightest erosion from steam, even with such abnormally wet steam as noted above.



FIGS. 1 AND 2.—SHOWING EROSION OF BLADES WITH A STEAM JET VELOCITY OF 600 FT. AND 2900 FT. PER SECOND RESPECTIVELY.

It is hardly necessary to point out that "the impressive list of practical qualifications" which Mr. Earl presents in favor of the engine, has been, with two exceptions, entirely met by the turbine. The exceptions are (1) extremely low speeds and (2) belted operation. Both are characteristics of passing engineering practice rather than present. The turbine in general meets the engine upon its own ground in every desirable particular, even to the economical use of exhaust steam at atmospheric pressure. Prof. Rateau has done notable work in this direction.

I agree with Mr. Earl that "the probable outcome of the situation will be a gradual specialization brought about by the test of experience." Considerable experience, however, has already been acquired which has apparently been overlooked in his article. The present position of the turbine is professedly one of specialization with no pretensions to the contrary. The generation of large powers for electric supply and industrial systems and for marine work is at present its admitted field; predictions regarding the future development of the turbine can hardly be made at this time with any degree of certitude.

JOHN R. BENSON.

Boston, June 4, 1904.

NOTES.

A Correction.—In our Exposition article last month it was stated, near the bottom of the second column, page 276, that a Commercial dynamo of 30 kilowatts output, direct driven by a gas engine, furnished power for the other working exhibits in the same space. This was an error; the three-bearing dynamo for gas engine drive is exhibited alone and not in operation.

The International Electrical Congress.—The membership of the International Electrical Congress to be held at the St. Louis Exposition, September 12 to 17, now numbers more than 1000, and more than 700 engineers have signified their intention of becoming members. More than 160 specially requested papers have been promised, a considerable number of which have already been delivered. Communications concerning the Congress should be addressed to Dr. A. E. Kennelly, Harvard University, Cambridge, Mass., who is the general secretary.

National Electrical Contractors' Convention On account of the exceedingly low rates issued by the several passenger associations between St. Louis and other points it has been unnecessary to secure a special rate on the certificate plan for the benefit of delegates and visitors to the National Electrical Contractors' Association, to be held at St. Louis, September 14, 15 and 16. A special convention train will leave the Grand Central Station, New York, on Saturday afternoon, September 10, at one o'clock, for St. Louis, where it is due to arrive on Sunday, September 11, at 6.45 p. m. Special provision is being made for the comfort of ladies traveling on this train. The headquarters for the Eastern delegates will be in the Washington Hotel, Washington Avenue and King's Highway Boulevard. Full information may be obtained from Mr. Alexander Henderson, 527 West Thirty-fourth Street, New York.

More Newspaper Science.—Two of our readers have favored us with the subjoined effusions clipped from daily newspapers which, although widely separated geographically, are evidently bound together by the tie of erudition. Concerning the proposed electrical equipment of the cog railway up Pike's Peak, one of them says:

> "The poles which will carry the wires will each have at the top a lightning rod designed to attract electricity which plays around the Peak so fiercely. The theory is that the poles will catch the 'juice' and transmit it through the rails of the cog road to the power house in Manitou, where it will be transformed and stored for use. They will take the electricity off the Peak and transmit to Manitou, where it can be used for driving trains up and down."

The other, after describing in flowery style the inauguration of a new electric power station, adds:

> "Of the manufacture of electricity it may be briefly said that the dynamo wheel whirls within a vertical circle of radiating soft iron wires. The wheel's surface is covered with many horseshoes of soft iron connected with the 'inciters' which send a current of electricity to them and thus form them into magnets. These magnets whirled before looped wires, charge them with electricity."

Which is not so very bad, after all.

Electric Hauling on Canals.—The results of the hauling experiments made by the Teltow Canal Building Commission, Germany, have just been made public. The locomotive used was designed by the Siemens-Schuckert Works; it has a front truck, both axles of which are driven by an 8-h.p. motor through double spur gearing. There is at the back a free guiding axle. On the truck there is a hauling pole 2.5 m. in length rotating around a horizontal shaft located above the driving axle and supporting at its upper end a funnel through which the hauling rope is slipped. The pole is moved by a 1-h.p. motor, through spur wheel and worm wheel gears. The hauling rope is wound on a drum, which is operated by a 2½-h.p. motor by means of a worm gear. In order to avoid any excessive strains on the locomotive, this drum is not made rigid with its shaft but connected to it through a friction coupling which is disengaged when the pull on the rope reaches 1150 kg. The weight of the locomotive is about 6.5 tons. As shown by the experiments, the pull on the rope is about 0.85 kgr. per ton of effective load, or 0.6 kgr. for a displacement of 1 ton, with a speed of 4 km. The output of the locomotive is 0.0127 horse-power per ton of efficient load or 0.010 horse-power per ton of displacement. Figures corresponding to speeds of 4.5 km. and 5 km. respectively were also ascertained, it being shown that 4 km. is the most economical speed, the consumption of energy at lower speeds being only a little smaller, while with higher speeds a relatively rapid increase is noted. The efficiency of the locomotive when hauling 600 or 1100 tons of efficient load is about 65 per cent.

The Steam Turbine in Germany.—The Siemens-Schuckert Works some time ago entered into a combination with some important firms; including Friedrich Krupp, The North German Lloyd and the Vereinigte Maschinenfabrik Augsburg & Maschinenbau Ges. Nürnberg, for the object of exploiting the Zoelly steam turbine built by the Swiss firm of Escher, Wyss & Co., Zurich. An improved type of this turbine is just being brought out. This is a multiple stage, axial flow turbine, in which the steam is conveyed to the running wheels through guiding wheels so as to have in the high pressure stage a partial and in the low pressure stage a full charge. The guiding wheels are fitted steam tight into the turbine casing, one running wheel being arranged between each pair of guiding wheels. The running wheels are mounted on a common shaft, traversing the whole length of the turbine. On the rims of the wheels are mounted the buckets, which have the form of relatively long rays, their cross section increasing at a regular ratio from the outside inward toward the axle of the wheel, thus maintaining constant the specific strain throughout the length of the bucket. The peculiar construction of the buckets will permit comparatively high wheel diameters and, accordingly, great peripheral speeds to be adopted, thus allowing of a relatively small number of stages.

A turbine direct coupled to a rotary current generator built by the Siemens-Schuckert Works is being operated in the workshops of the company, giving an output of 600 e.h.p. Recent tests made on this turbine by Prof. A. Stodala gave the following results:

KILOGRAMS OF STEAM PER KILOWATT-HOUR.

Saturated steam:	Kg.
At no load without excitation, 205.4 kg. t'tl.	
At no load with excitation, 465.4 kg. t'tl.	
80.1-kw. output	15.0
182.2-kw. output	11.7
240.1-kw. output	10.9
334.5-kw. output	10.1
387.6-kw. output	9.74
II. Superheated steam:	
390.4-kw. output 220° superheat	8.98
391.7-kw output 240° superheat	8.63

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Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

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The American Electrician has a larger paid subscription list than any other electrical journal in the world.

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The Electric Light Convention.

The Boston convention of the National Electric Light Association was an extremely satisfactory one from every standpoint, so far as an "outsider" is able to judge. The attendance was large, the interest well sustained and the papers rather above the average in quality. There were the inevitable exploitation papers which everybody listens to with more or less resignation, but the ratio of these to the whole was very small. The exhibits were noticeably diminished as compared with previous years, which is easy to explain. This association has for several years been steadily approaching the status of a strictly technical body so far as attention to the regular proceedings is concerned; there is far less of rollicking and indulgence in what might be termed incidental pastime than ever before, and much more earnest attention to the papers and discussions.

It is doubtful if 10 per cent of the delegates to the Boston convention manifested any interest in exhibits which did not include some actually novel features; it appeared to be a "strictly business" gathering. Of course, this has its disadvantages for the progressive manufacturers who went to the expense of making exhibits, but it is a very natural development. The central station business has long since narrowed down to a business proposition requiring for its success the highest order of administrative ability, so that the delegates to these conventions have first and foremost in mind the necessity for exchanging experiences and views and gleaning any information that will assist in promoting the success of their establishments; information regarding apparatus and appliances is obtainable at any time with the utmost facility and minimum effort on their part. Consequently, the interest in the meetings is steadily growing and that in the exhibits is decreasing.

◆◆◆

The Steam Turbine and the Gas Engine.

The papers on these subjects which were read at the convention were mostly disappointing, but the discussions were somewhat instructive. As we remember them now, these papers contained very little that had not been said from once to half a dozen times before, and nothing at all conclusive. Just why any author of a paper to be read before a body of this sort should imagine that those present will be interested in a detailed description of machinery or apparatus which has been copiously described in the technical press long before, is a question to which we have never succeeded in formulating an answer entirely flattering to the author. With this class of material eliminated from the papers mentioned, much time could have been saved and the remainder of the material would have been more effective.

The merits of the steam turbine, as well as its demerits, in its present stage of development are too well known to require enumeration, and we would not presume to venture anything like a prediction as to the future. So fas as one may judge from what has already been accomplished, however, it is reasonable to believe that the internal-combustion engine has far greater possibilities of future development than any other form of prime mover now known. The serious obstacles in the path of gas engine development are the producer problem and the valve-gear, principally the former; this has only begun to receive serious attention in this country, however, so that it is too early to feel discouraged about it. The valve-gear problem is not nearly so serious, but it is an extremely knotty one. That the gas engine valves and gear will eventually be reduced to smoothness and reliability of operation equal if not superior to those of a releasing-gear steam engine cannot be safely questioned, however, and if American engineers *should* fail to bring the producer up to the desired degree of commercial efficiency, it is highly probable that the oil engine will receive the attention which it deserves, but has never had, always excepting the praiseworthy efforts of Herr Diesel.

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The Double-Voltage Arc Lamp.

The arrangement of two pairs of carbons connected in series in a single arc lamp and burning simultaneously dates back almost to the beginning of the art. In our callow youth we "invented" such a lamp, only to discover that we had been saved the trouble several years previously. But there was no real need for such a lamp in those days of simple series circuits. Now, however, the extended use of arc lamps on constant-potential circuits, combined with the steady rising of constant-potential standard voltages, bids fair to change this considerably. A double-voltage lamp is being used in Providence, R. I., on 250-volt circuits and in large numbers, and there is no reason why this type should not prove immensely useful on circuits of lower potential. The enclosed arc works best at 70 to 80 volts potential difference, but it does very nicely with 60 to 65 volts;

circuits of 110 volts nominal are usually operated at from 115 to 125 volts, and there is no objection whatever to running them up to 130 volts, except that 130-volt incandescent lamps are not regarded as "standard." At this voltage a differential double-voltage lamp will operate very satisfactorily. If the standard voltages were raised to 165, 330 and 660, as suggested in another paragraph, double-voltage arc lamps would fit in beautifully, the limit of economical distribution area would be increased approximately 300 per cent and wiring installations would not require logs of copper in the heavy duty lines.

◆

Armature Windings.

As we intimated briefly in a previous number, the grasp of the principle of armature winding is immensely facilitated by considering the winding on the basis of coils instead of conductors. The only argument against this method is that in large armatures a "coil" is not a coil at all, but a loop. This has no more practical bearing than would the argument that the divisions of a commutator should not be called segments because they are not segments in the common geometrical sense. At any rate, if one's ideas of definition are too rudely violated by calling a loop a coil, there is the alternative of calling it by its right name, "loop." The fact remains, regardless of these semi-quibbles, that the practical armature winder not only does not need to know anything about front and back armature pitches, re-entrancy and the rest of the academic terms that delight the heart of the text-book writer, but is merely confused and hampered by them. And while students and designers may be able to get at fundamental principles by way of these devious methods, it is vastly easier to do so without them.

There are two generic types of winding: lap and wave, when reduced to one turn per coil or pair of inductors (in a drum winding). The former have been appropriately termed "multiple" windings, but a wave winding can also be a multiple winding. Either "lap-connected and wave-connected" or "lap-lead and wave-lead" would be more distinctive and descriptive; "equipotential" would fit the wave or wave-lead winding, but it is a clumsy word and there is no antonym, even if a lap winding were inherently non-equipotential. However, no matter what one chooses to call the two types, the only features necessary for one to know are the number of coils and the method of connecting coil terminals to the commutator. The pitch at the armature core has no effect whatever upon the type of winding so long as the two features mentioned are correct; the spread of a coil on the core affects commutation chiefly and the generated e.m.f. to a slight extent, assuming that the spread is somewhere near the pole pitch. The simple wave or wave-lead winding may have any even number of paths up to the number of field magnet poles, while the lap or lap-lead winding necessarily has a number of paths equal to the number of magnet poles, unless it is a duplex or triplex winding. Each set of coils forming one path in a wave-lead winding is subjected to the inductive influence of every magnet pole on the machine simultaneously, so that the e.m.f. is exactly the same in every path; each set of coils in a lap-lead winding, on the contrary, is under the influence of only two magnet poles at any given instant, so that if there should be any difference between the strengths of field under the different pole-faces, different e.m.fs. will be induced in the different paths and cross-currents will flow backward through the paths generating the weaker e.m.fs., overheating the armature dangerously. These are the fundamental characteristics of the two types of winding.

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A 500-Volt, Three-Wire, Direct-Current System.

The paper on this subject, which we print elsewhere in this number, will undoubtedly be read with keen interest by central station managers who did not hear it read at the convention. The author describes a very bold policy which appears to have been vindicated by actual application for a period of about three years. For several years we have steadily advocated raising the standard constant potentials to something like 150, 300 and 600 volts, but Mr. Barnes and his associates in Providence have gone 66 per cent beyond our modest suggestion at one leap. Admirable as their progressive daring and intelligent execution are, we are unable to believe that the plan they have adopted is advisable; 500 volts is a very high potential to introduce in people's houses, to begin with, and 250-volt incandescent lamps do not appeal to our ideas of economy. There are, it seems to us, many more but less important reasons why 300 or 330 volts would be a better over-all voltage for a three-wire system than 500, but those just mentioned would be ample to deter us from assuming the responsibility of a 500-volt system. There is no doubt, however, that the present so-called "standard" voltages of 110, 220 and 500 are out of date; there is also no doubt, at least in our mind, that the two higher direct-current voltages should be multiples of the lowest one, whatever that one may be.

The use of the structure of a steel frame building as the neutral conductor for all branch circuits also appears to be unnecessarily radical. The neutral of the system should, of course, be securely "grounded," but dependence upon the frame of a building for one side of a work circuit does not impress us as sound engineering practice. It has a great advantage in simplifying branch circuits and switches, but cases have been known where great simplicity has proved more expensive in the long run than a more complex arrangement.

◆

Electric Heating.

One of the most reasonable utterances from a manufacturer concerning his own class of apparatus that have come within our knowledge recently was the paper on this subject that was read at the Electric Light Convention by Mr. James I. Ayer. The author made no effort to persuade the central station fraternity that electric heating is a commercial proposition regardless of conditions, which is, unfortunately, the attitude that manufacturers are apt to take regarding their own lines of apparatus. His paper very clearly points out the limitations of electricity as applied to heating, but it also contains some valuable suggestions as to the conditions under which electric heating can be made profitable. Making allowance for just a wee bit of entirely human bias, the paper may be regarded as a very safe guide regarding this class of central station service.

There is no reason to doubt that if central stations could afford to put out electric heating apparatus on the same basis as arc lamps, a very considerable addition to the station load could be worked up for the warm and hot months of the year, and possibly for the milder months of May and October in southern latitudes. It is a question, of course, whether or not it would pay to put out apparatus and maintain it free in order to get a relatively moderate increase in load, at reduced rates, during four months of the year; in the abstract it seems a little dubious, but it is a matter to be figured out according to individual operating conditions, of course. There is no doubt whatever, though, that a heating load will be profitable during the "short load" months, at the reduced rates necessary to obtain it, if the customer can be persuaded to buy or rent his apparatus.

DESIGN FOR A LIGHT GASOLINE MOTOR CAR.

BY J. C. BROCKSMITH, M. E.

The accompanying working drawings illustrate a type of gasoline automobile which is about as light and simple in construction as such a machine can be made consistent with good results and still be within the reach of the amateur builder and automobile enthusiast. The well-known arrangement of "motor in front, sliding gear transmission, and bevel gear drive" has been adopted as representing the best practice for light cars. Fig. 1 is a side elevation of the complete machine, which shows the general arrangement and appearance of the car.

The motor is a two-cylinder vertical machine of the two-stroke-cycle type; it is air cooled and located under a well ventilated bonnet in front. The motor has an output of 6 horse-power at the normal speed of 750 r.p.m. The power is transmitted through a cone clutch in the fly-wheel to the transmission gear which provides forward speeds of 6, 12 and 25 miles an hour and one reverse speed of 6 miles an hour, all at the normal motor speed of 750 r.p.m. It will be understood, however, that any intermediate speed can be obtained by the usual methods of shifting the spark and throttle control. The rear axle is driven through a universal joint and bevel gear, the latter being enclosed in the same case which contains the differential gear.

Steering is effected by means of a hand-wheel operating a screw and nut and is of the "irreversible" type; that is, no inequalities in the road can work back through the steering linkage and produce a motion of the hand-wheel. Upon the steering column are also mounted the spark and throttle levers, by means of which the speed of the motor is controlled. The machine is further controlled by means of the clutch release and brake pedals which are seen protruding above the inclined footboard. The gear is changed by means of the lever shown alongside the seat on the right-hand side. When changing from one gear to the next, the clutch pedal must, of course, first be depressed, thus disengaging the motor from the transmission, so that no power is passing through the gears and they can be brought into mesh without danger of stripping the teeth.

The brake acts on the secondary shaft of the change gear, and being geared up to the rear axle in the ratio of 4 to 1 a very powerful braking effect is obtained with a moderate size of brake drum and a comparatively light pressure by the brake.

The gasoline tank is located directly under the seat and is filled through the cap shown in the top, which can be readily got at by removing the seat cushion.

The wood work of the seat is of the simplest possible description, only straight boards being used; the curved surfaces usually seen on automobile bodies would probably be out of the question for anyone who wished to construct the wood work himself.

The body is hung on three springs, a semi-elliptic spring being used in front while the rear springs are full elliptic. The wheels are 28 inches in diameter, have wooden spokes and are equipped with 3-in. detachable pneumatic tires. Fig. 3 is an end elevation of the complete machine which brings out a number of dimensions and points of construction not clearly indicated in Figs. 1 and 2. The front spring is a 38-in. 5-leaf semi-elliptic spring fastened at its extremities to a pair of short links to allow for extension, and at the center is bolted to a wooden cross-bar which is shaped to fit the curvature of the spring and which supports the frame and body of the vehicle. The front axle is given a drop of 1¼ inches below the center line of the wheels in order to give additional room for deflection of the springs and thus prevent the motor shaft from striking the axle.

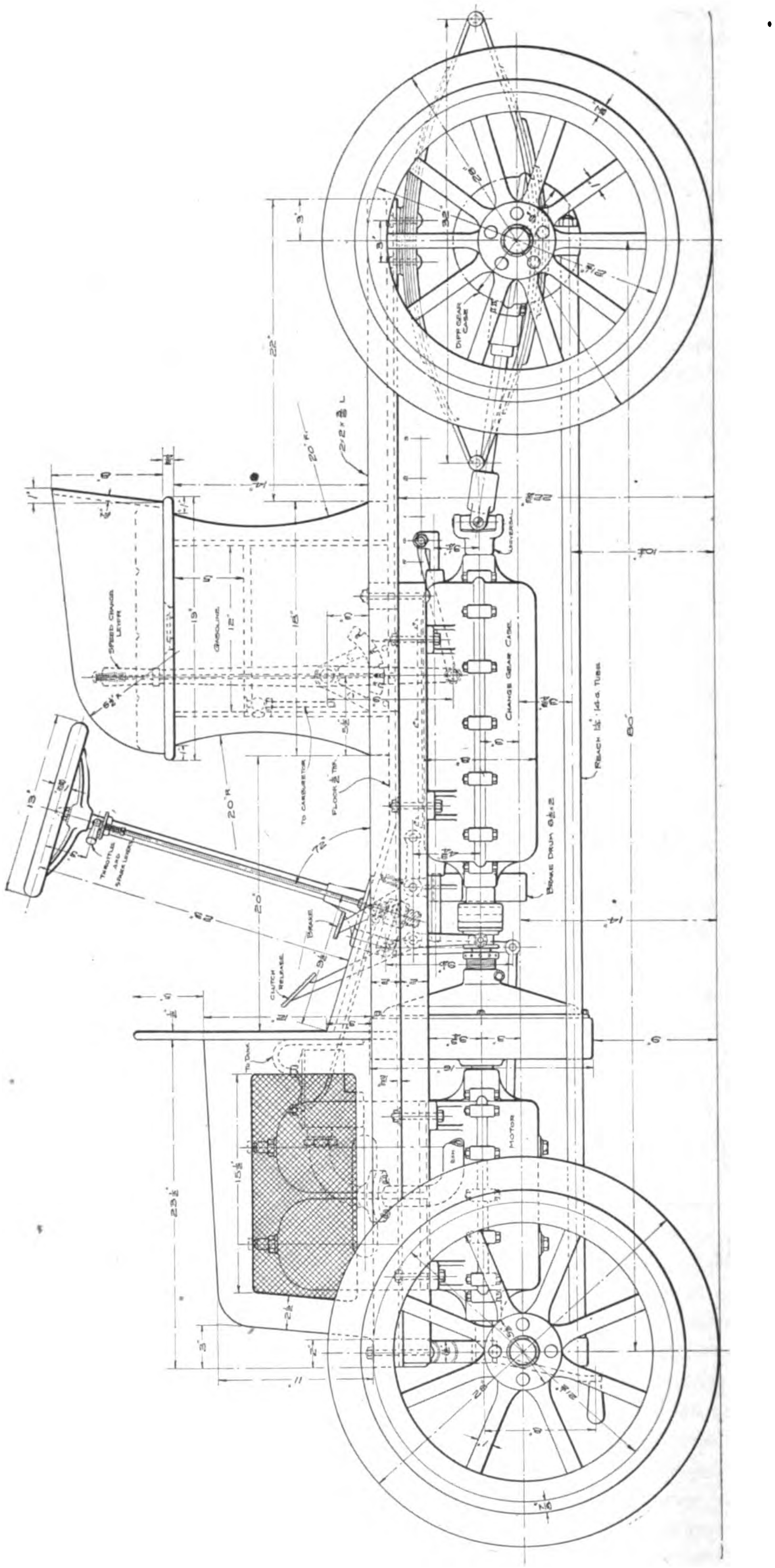


FIG. 1.—SIDE ELEVATION OF COMPLETE MACHINE.

This view also shows a section of one of the wheels, which brings out the construction of the hub and the form of the rim and tire, the latter two being of standard section and dimensions. The construction of the seat is also indicated in the view; it will be noted that the sides are inclined outwardly and come inside the flanges of the angle iron frame at the bottom, being fastened thereto by means of screws. The steering column is shown on the right-hand side of the machine, as this side is considered in common practice to be the best for operating the machine.

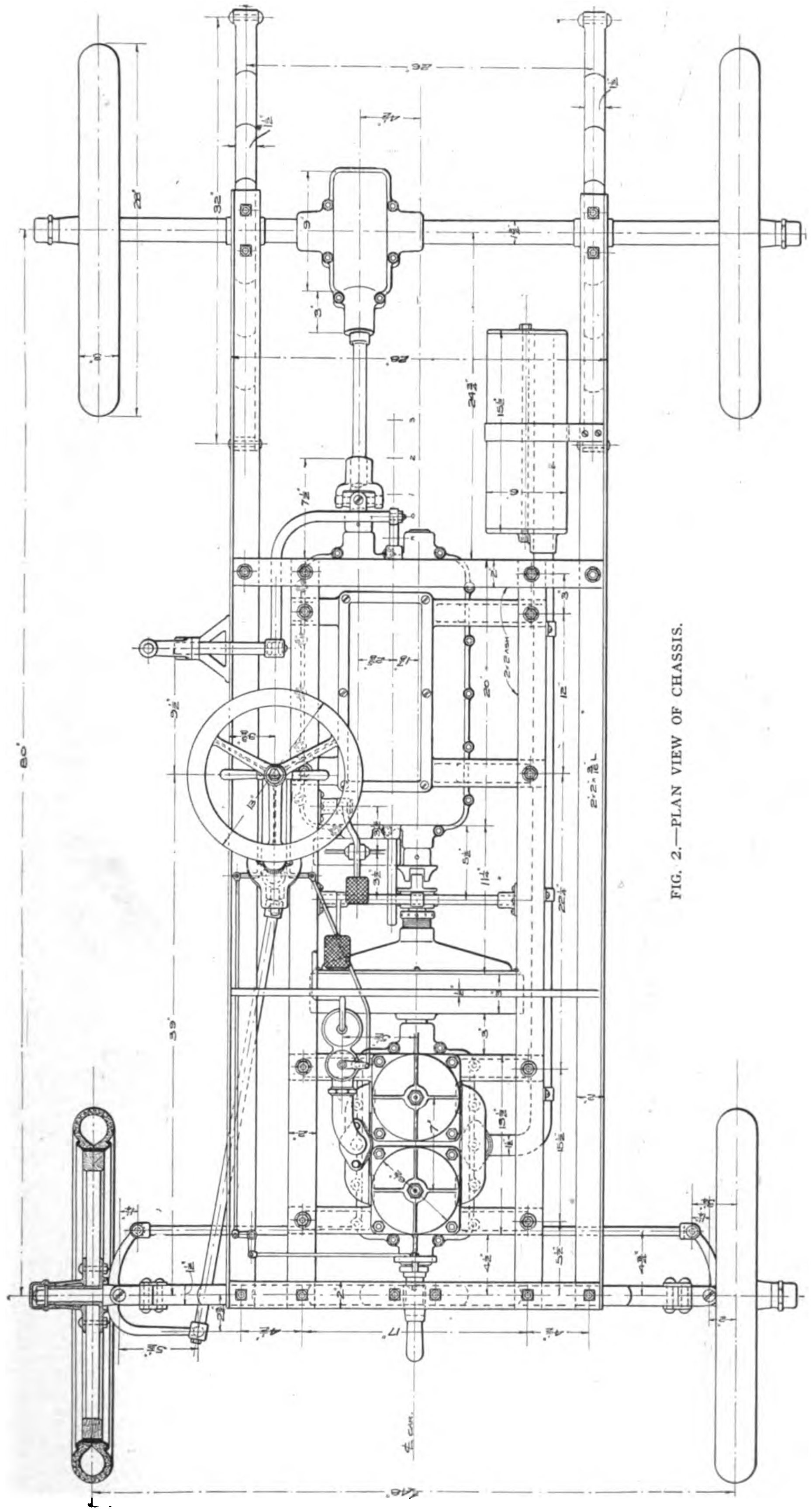


FIG. 2.—PLAN VIEW OF CHASSIS.

Fig. 2 shows a plan view of the chassis. This shows all the operating parts in their proper relation and is probably the best drawing to work from in assembling the machine. The frame is composed of two lengths of 2-in. x 2-in. x 3/16-in. angle steel, each 84 inches long. Across the front is bolted a piece of 2-in. ash which is shaped to fit the spring; ⅜-in. carriage bolts may be used for this, and a washer should be used under the nut to prevent it from cutting into the wood. Bolted to the under side of this cross-piece in front are two longitudinal frame members of 2-in. x 2-in. ash, to which the motor and change gear case are bolted. The rear ends of these longitudinal members are supported by a 2-in. x 2-in. cross-piece, which is in turn bolted to the bottom flanges of the angle-iron frame. The clutch release and brake pedals, it will be seen, are swung on rods attached to the wood frame members. The curved connecting link which moves the sliding gear shifter and connects with the hand lever is clearly indicated in this view. It is made of the peculiar shape shown in order to avoid interference with the frame members.

The exhaust pipe and muffler, which are represented as broken away in Fig. 1, are shown in position in this view. The exhaust pipe consists of a length of 1½-in. steel tubing, bent to suit the frame members in front and fastened thereto by means of small clips of ⅛-in. x 1-in. iron. The muffler is simply a hollow sheet metal cylinder, with cast heads bolted in by means of a through bolt and perforated with numerous small holes on the under side; the aggregate area of the perforations should be about equal to the area of the exhaust pipe in order to avoid undue back pressure. It is probable that a length of common 6-in. stove pipe will answer for the cylindrical part. If this is found to have an undesirable amount of resonance, it may be wound with wire, which will stop the vibration of the walls and will also help to strengthen them. It will probably be necessary to have a cross member in the frame at the extreme rear. The frame is left long in the rear to allow for the addition of tonneau seats if the builder finds them desirable.

The Motor.

Fig. 4 is a front vertical section through the completed motor, which shows the location of the various ports and passages. The motor has no valves and the pistons act as valves, opening and closing the inlet and exhaust ports in the usual manner of two-cycle motors. The cylinders are 4 inches bore by 4 inches stroke. The crank case is divided into halves along a horizontal plane and is of comparatively small diameter, the fly-wheel being placed outside. Arms are cast on the top half of the case, by means of which it is bolted to the frame of the car so as to afford proper clearance for the rotation of the fly-wheel. The pistons are long and have three rings for packing, which are made wider than the ports in the cylinder walls to avoid any liability to catching.

Both the inlet and the exhaust sides of the cylinder are provided with branch pipes; the connections for the main pipe in each case should be inclined to the axis of the cylinder, as shown in Fig. 5. The spark plugs are tapped into the center of the cylinder head, where they are in a good position to ignite the charge and are also accessible for inspection and cleaning when this becomes necessary.

Fig. 5 is a semi-sectional side view of the complete motor. This shows the transfer passages connecting the cylinder with the crank case and also the shape of the deflecting vanes on the piston head. The contact maker is shown on the front bearing boss and is adapted to be rotated about the cam through a certain angle, thus varying the period of ignition in the customary way. The shaft is extended somewhat on this end for fitting on the starting crank.

Fig. 6 gives the details of the cylinder: these should be cast of good close-grained gray iron, and the bore should be finished as smooth and true as possible. The cylinder wall is 5/16 inch thick and is provided with 23 cast flanges, 15/16 inch high, for cooling. The vertical section shows the size and proper location of the ports, the transfer ports being two in number ¼-in. x 1¼-in. opening, and the inlet and exhaust ports are each 5/16 in. x 2 ins.

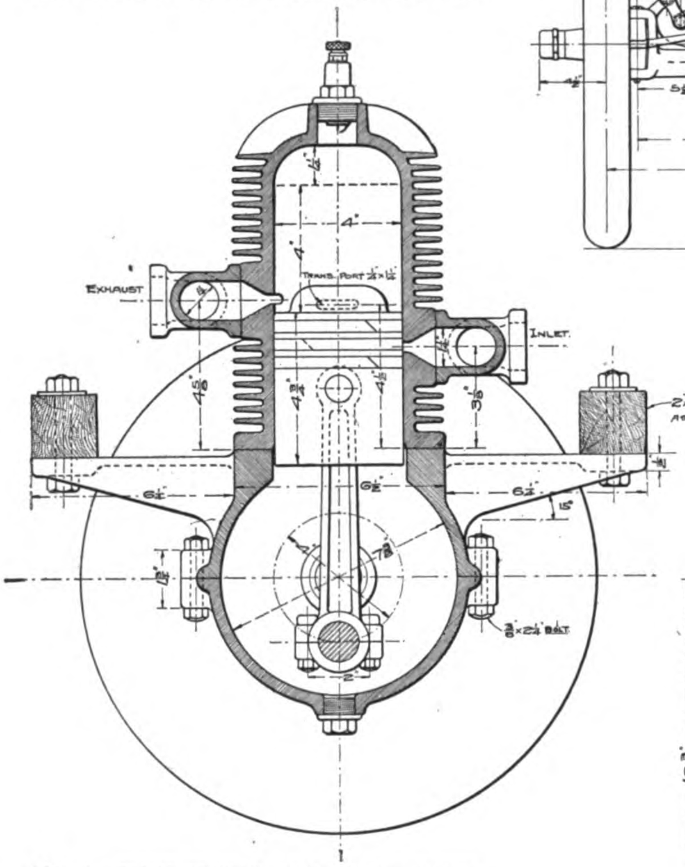


FIG. 4.—FRONT SECTION OF GASOLINE MOTOR.

Fig. 7 is a detail of the piston; it has three grooves turned for ⅜-in. rings. The rings should be turned about 1/64 inch larger than the bore of the cylinder and ⅛ inch thick. They are then cut through with a diagonal slot and should be fitted to the bore so that the ends stand a trifle apart to allow for expansion when they heat up during operation. The body of the piston should be turned about three one-thousandths small for the bore of the cylinder, and the grooves should be turned a nice fit for the rings, which can then be snapped into place and pinned to the piston so that the joints will not be required to traverse that portion of the cylinder which is broken by the ports. The wrist pin is ⅞-in. cold rolled steel and is held in position by two ¼-in. set screws in the inwardly projecting bosses.

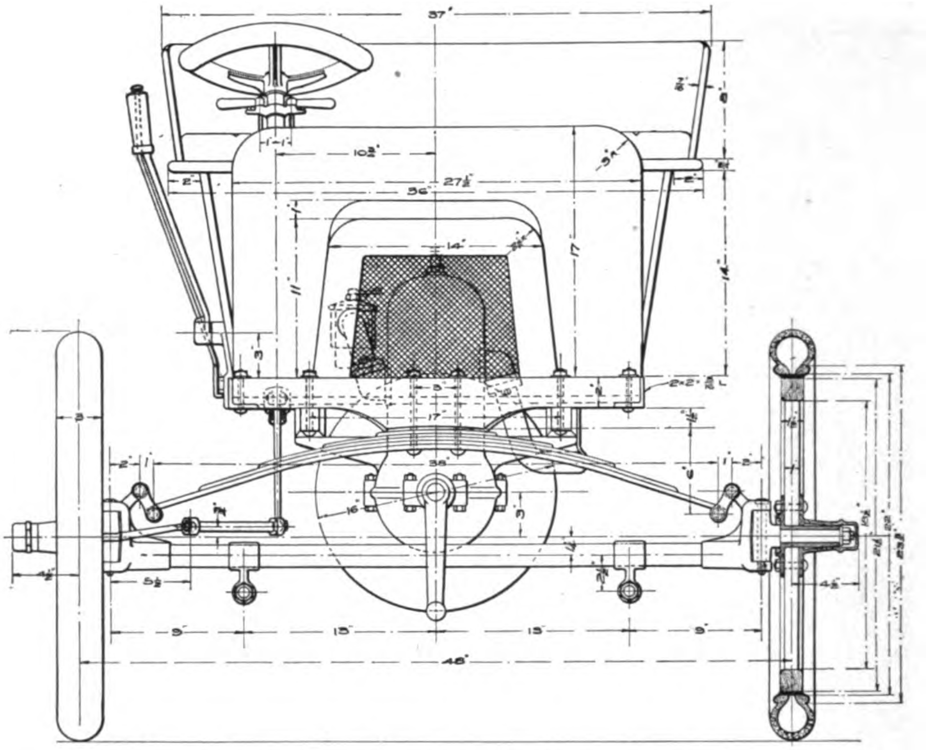


FIG. 3.—END ELEVATION OF COMPLETE MACHINE.

Fig. 8 is a detail of the connecting-rod. This is intended to be a phosphor-bronze casting. Provision is made at both ends of the rod for taking up water. The body of the rod is of "I" section with a 3/16 in. web.

Fig. 9 shows the crank shaft. This is preferably made from a solid open-hearth steel forging, the cranks being cut from the solid metal. Figs. 10 and 11 show respectively the top and bottom halves of the crank case. These are intended to be cast in

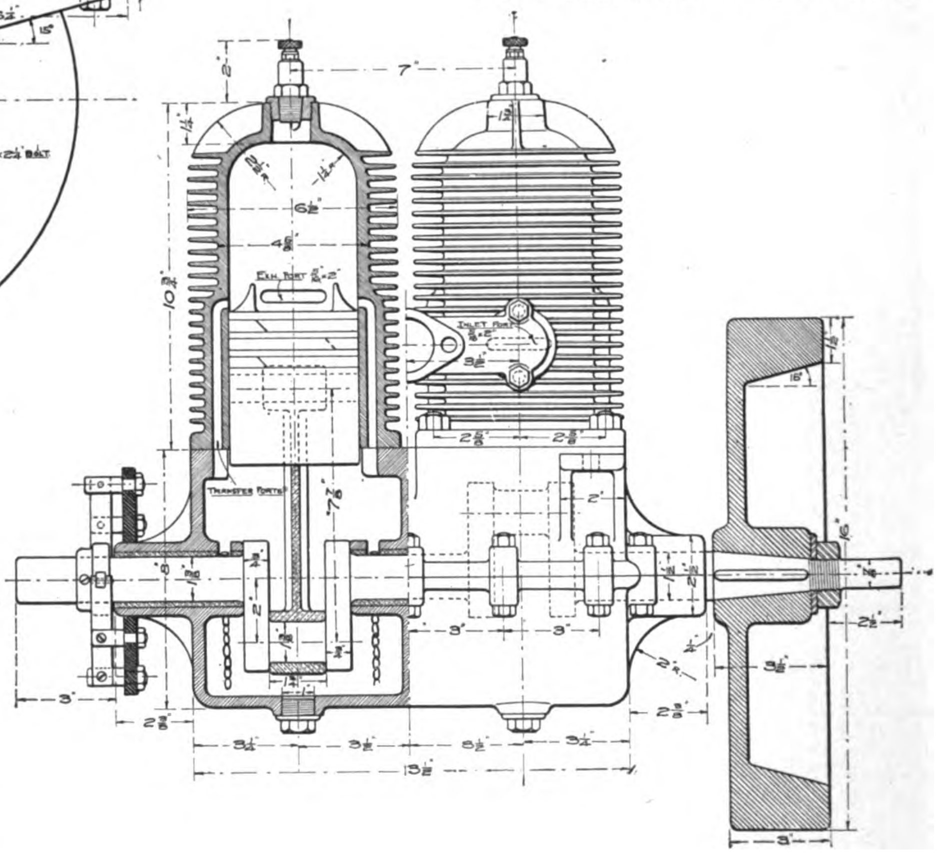
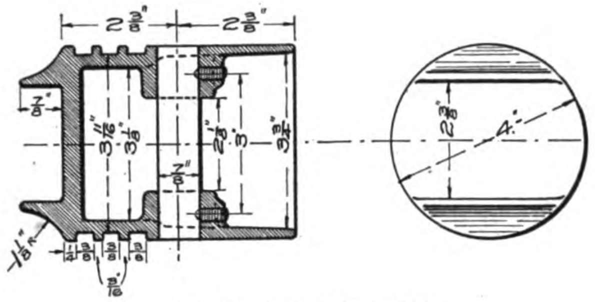


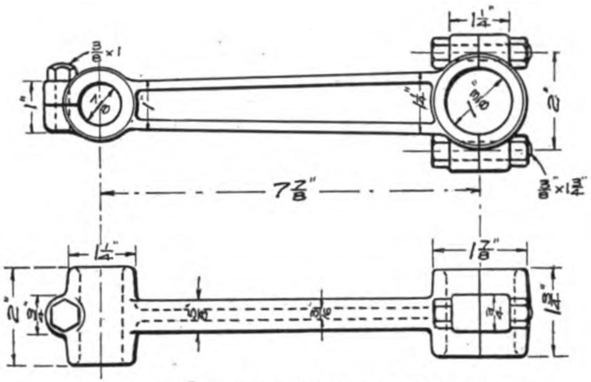
FIG. 5.—SIDE SEMI-SECTION OF GASOLINE MOTOR.

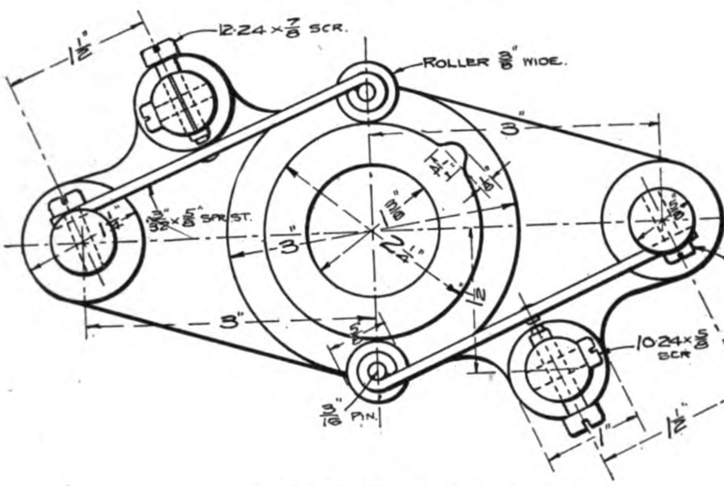
aluminum alloy containing about 25 per cent zinc. The halves should be planed and carefully surfaced where they bolt together; this joint should be perfectly gas tight, and it is preferable not to use packing but to rely on the surfacing and the bolts for drawing the parts in close contact.

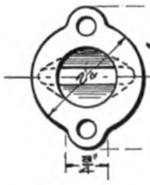
Fig. 12 is a detail of the contact maker for use with jump spark ignition. A spark is required in each cylinder once in each revolution, and since the cranks are at 180° the contacts are also arranged 180° apart. The plate upon which the contacts are mounted is bored for and centered upon the main bearing boss. This plate may be made of aluminum or brass and only the stationary contacts need be insulated from it. That is to say, the spring blades are grounded on the engine frame, which is a necessary part of the scheme of connections.

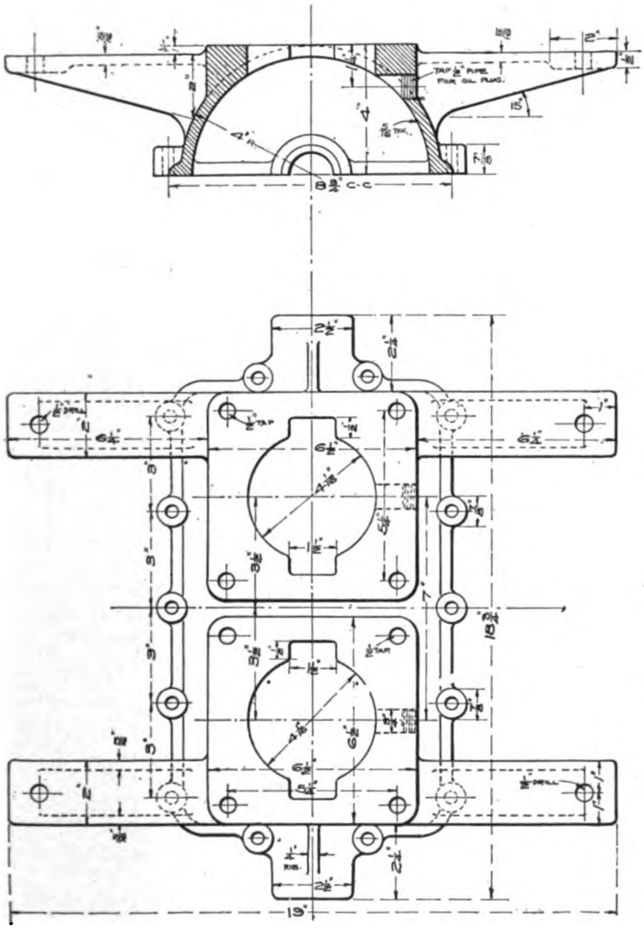
Fig. 13 is a diagram of connections of

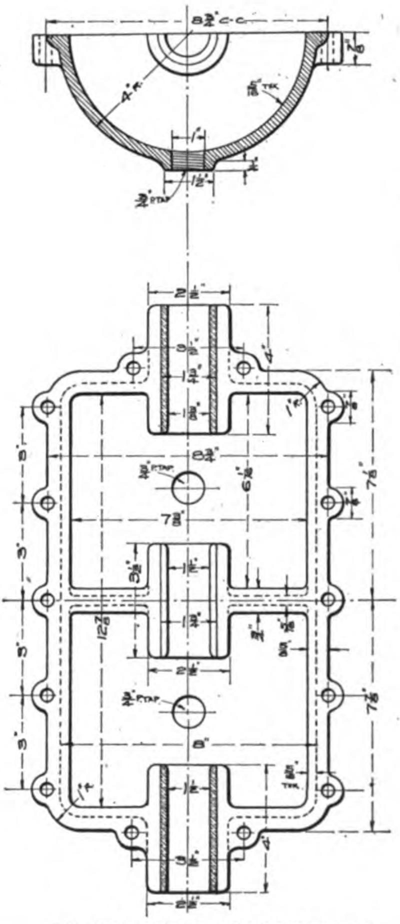

2 3/8"
2 3/8"
3 1/4"
4"
1/8" R.
FIG. 7.—DETAIL OF PISTON.

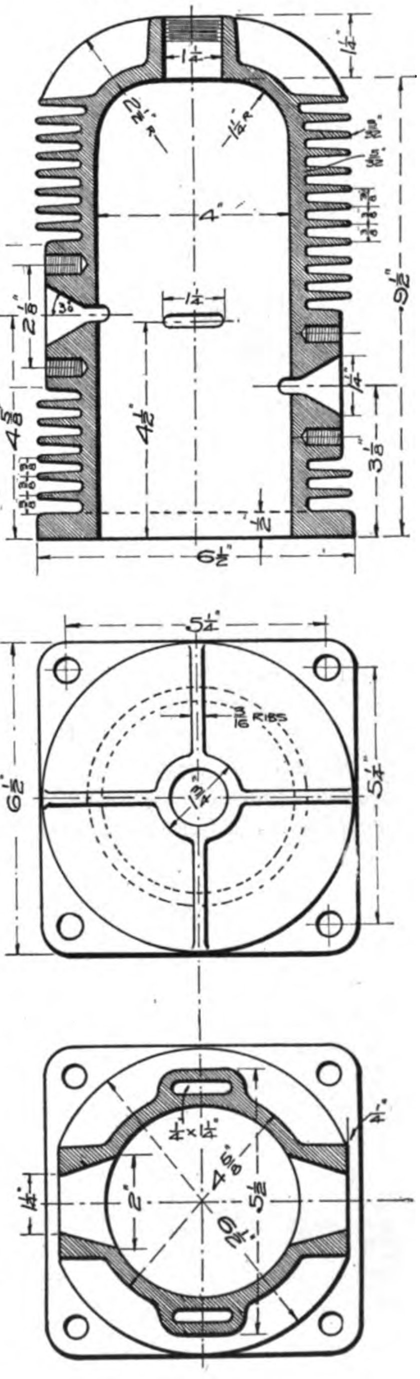

1 1/4"
7 7/8"
2"
1 7/8"
1 3/4"
FIG. 8.—DETAIL OF CONNECTING ROD.


12-24 × 3/8 SCR.
ROLLER 3/8" WIDE.
3"
SPR. ST.
3"
10-24 × 5/8 SCRS.
10-24 × 5/8 SCR.
3/16" PIN.
FIG. 12.—DETAIL OF CONTACT MAKER.




TAP 1/4" PIPE FOR OIL PLUG.
15°
4" R.
8 3/4" C-C
2"
6 1/2"
3"
19"
FIG. 10.—DETAIL OF UPPER HALF OF CRANK CASE.


8 3/4" C-C
4" R.
2 1/4"
8 3/4"
7 3/4"
3"
8"
FIG. 11.—DETAIL OF LOWER HALF OF CRANK CASE.


1 1/4"
1 1/2" R.
4"
9 1/2"
6 1/2"
5 1/4"
6 1/2"
5 1/4"
RIBS
2"
FIG. 6.—DETAILS OF CYLINDER.

the sparking apparatus. A separate coil is required for each cylinder. For spark coils and plugs the builder will do well to purchase standard articles. Also in regard to the carburettor, it is probable that more satisfactory results will be obtained from a ready-made article than from one of the home-made variety.

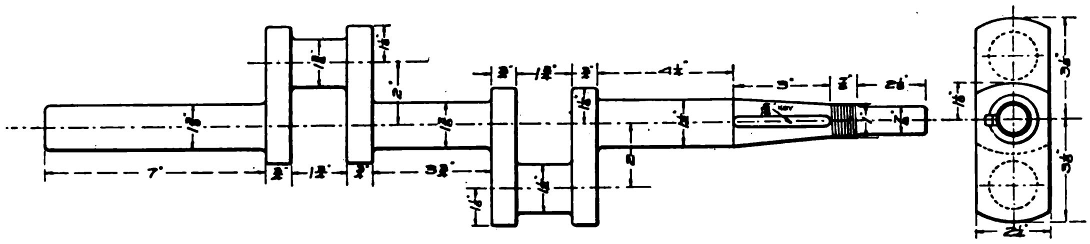


FIG. 9.—DETAIL OF CRANK SHAFT.

Fig. 14 shows the details of the motor fly-wheel and clutch. The wheel is of cast iron and is to be turned all over, the inner surface of the rim being finished to a 15-deg. taper and forms the female portion of the cone clutch. The male portion of the clutch is a disc of aluminum alloy faced with leather and riveted to a steel center which is bored to fit the reduced end of the crank shaft. A spiral spring forces this disc into contact with the fly-wheel surface, so that the cones are always in engagement except when the clutch pedal is depressed while changing from one gear combination to another. The spring pressure thus applied is entirely self contained and does not produce any end thrust upon the motor or change gear bearings, due to the fact that the fly-wheel is covered by a cap which takes care of this thrust and at the same time forms a dust-proof cover for the parts. In order to disengage the clutch the shaft carrying the male cone must have an endwise motion of about ½ inch, which is allowed for in the jaw clutch that connects the motor shaft to the speed change gear.

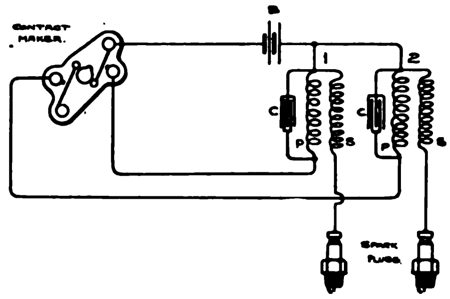
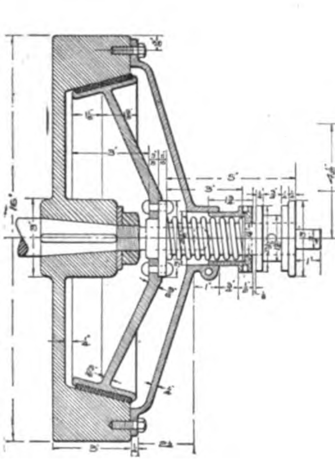


FIG. 13.—DIAGRAM OF IGNITER CONNECTIONS.



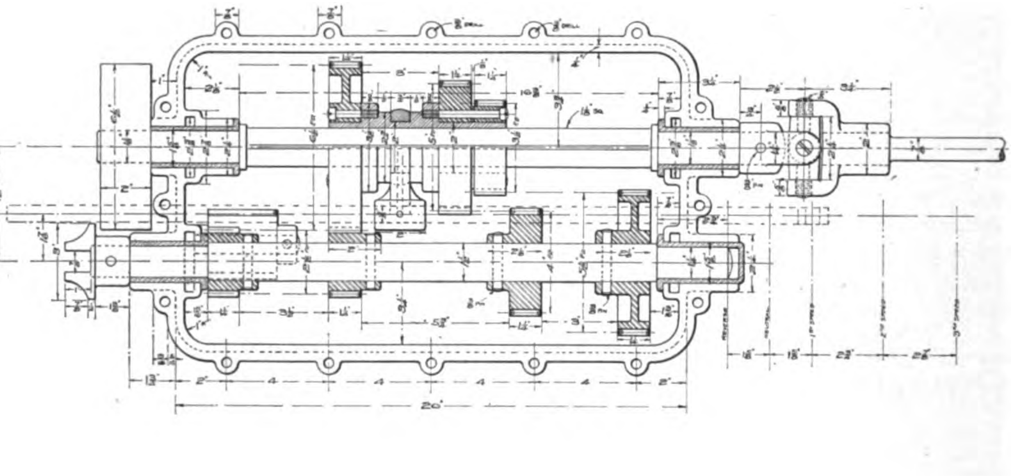
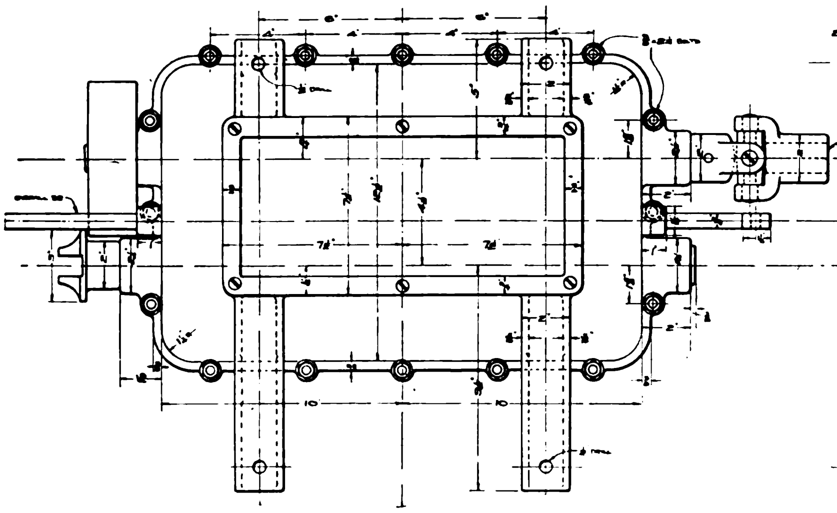


FIG. 14.—DETAIL OF FLYWHEEL AND CLUTCH; AND PLAN VIEW OF CHANGE GEAR CASE— FIG. 15.



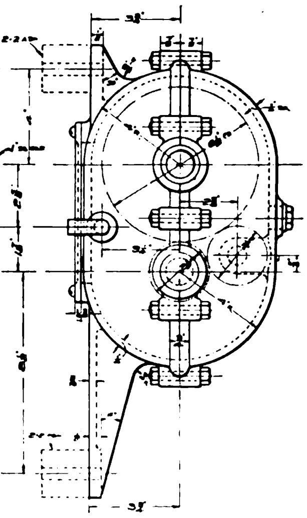


FIG. 16.—PLAN AND END VIEWS OF COMPLETE CHANGE GEAR CASE—FIG. 17.

Transmission Gear, Axles, etc.

Fig. 15 shows the speed change gear, with the top half of the case removed to make clear the arrangement of the gears and their operation. The driving shaft is round and has secured to it by means of pins four gears of different diameters. The driven shaft is square and has mounted upon it a spider carrying three gears of suitable diameters to mesh with the gears on the driving shaft. The spider may be slid endwise along its shaft so that any desired pair of gears may be engaged. The drawing shows the gears engaged for the first forward speed, which gives the highest ratio of engine turns to rear wheel revolutions. The reverse speed gives the same ratio as the first forward speed except that an idler gear is interposed between the driving and driven shaft, thus changing the direction of rotation. The reverse gear is obtained by moving the gears to the left of their position in the drawing and the two other forward speeds are obtained by moving the spider to the right of its present position. The center lines at the extreme right of the figure indicate the exact distances through which the

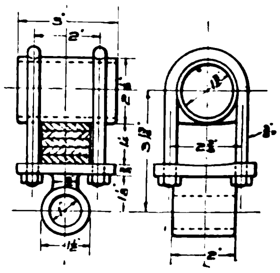


FIG. 19.—DETAIL OF REAR AXLE SPRING CLIP AND REACH-FITTING.

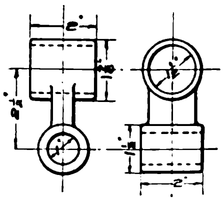


FIG. 21.—DETAIL OF FRONT AXLE REACH-FITTING.

shifter rod must be moved to get the various combinations. The universal joint which transmits the motion to the rear axle gear and also the brake drum are shown in this view. The accompanying table gives the data for gear ratios and sizes of gears for various combinations:

Table 1.—Change Gear Data.

Speed.	Pitch diameter of gears. Driving shaft.	Pitch diameter of gears. Driven shaft.	Gear ratio.	Total gear ratio to rear axle.	R.p.m. rear wheels.	Car miles per hour.	Motor r.p.m.
Reverse and 1st	2½"	6½"	2.6	10.4	72	6	750
2nd	4	5	1¼	5	144	12	720
3rd	5½	3½	0.635	2.55	300	25	765

Bevel gear ratio 4.1. Change gears, 8 pitch.

Fig. 16 is a top view of the complete gear and case, showing the lengths of arms for bolting to the frame work of the car, the shifter rod, brake drum, removable cover, and universal joint. Fig. 17 is an end view of the gear case, which helps to make clear the position of the idler gear by means of which the reverse speed is obtained. It also shows the screw plug at the bottom of the case, through which the old oil may be drained off. The case should always be partly filled with a heavy oil and the gears and bearings are then lubricated automatically. The best practice indicates that all gears should be cut from machine steel, have the teeth rounded or beveled on the edges, and then case hardened. If for any reason this is impracticable, phosphor-bronze might be used, though it will not, of course, wear as well. Cast iron is, of course, out of the question, as it is so brittle that the teeth would be likely to strip in changing speeds.

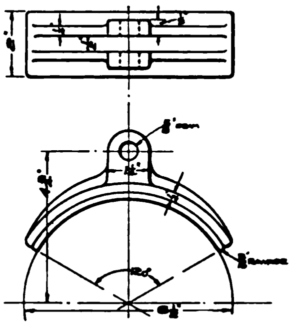


FIG. 26.—DETAIL OF BRAKE SHOE.

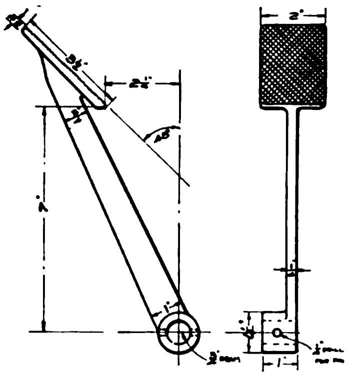


FIG. 23.—DETAIL OF CLUTCH RELEASE PEDAL.

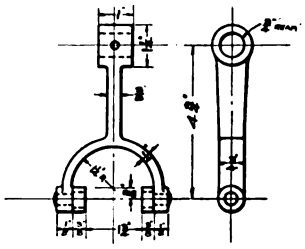


FIG. 24.—DETAIL OF CLUTCH FORKED LEVER.

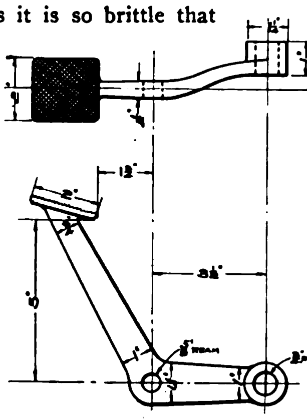


FIG. 25.—DETAIL OF BRAKE PEDAL.

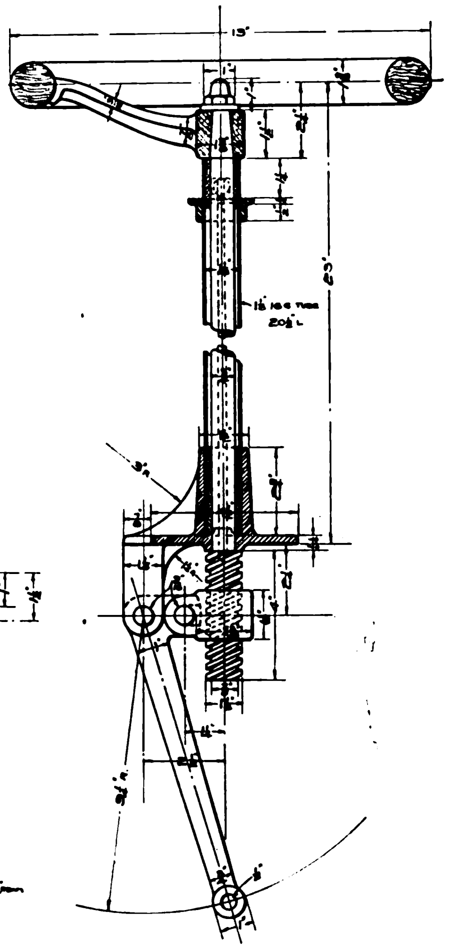


FIG. 22.—DETAIL OF STEERING COLUMN.

Fig. 18 shows the construction of the rear axle and the bevel gear drive. The revolving portions of the axle are of 1⅛-in. solid steel turned down to 1 inch at the hubs and keyed in. The differential gear is of standard construction and is therefore not detailed. The hubs may conveniently be of phosphor-bronze or steel. The gear case is intended to be cast of aluminum alloy containing 25 per cent zinc. The same is used for the engine crank case and the change gear case. The revolving portions of the axle are enclosed in a 1¾-in. steel tube which is fitted with phosphor-bronze bushings at its extremities. It will be noted in this connection that only plain bearings are used all through the construction of the car. Fig. 19 is a detail of the spring clip fitting

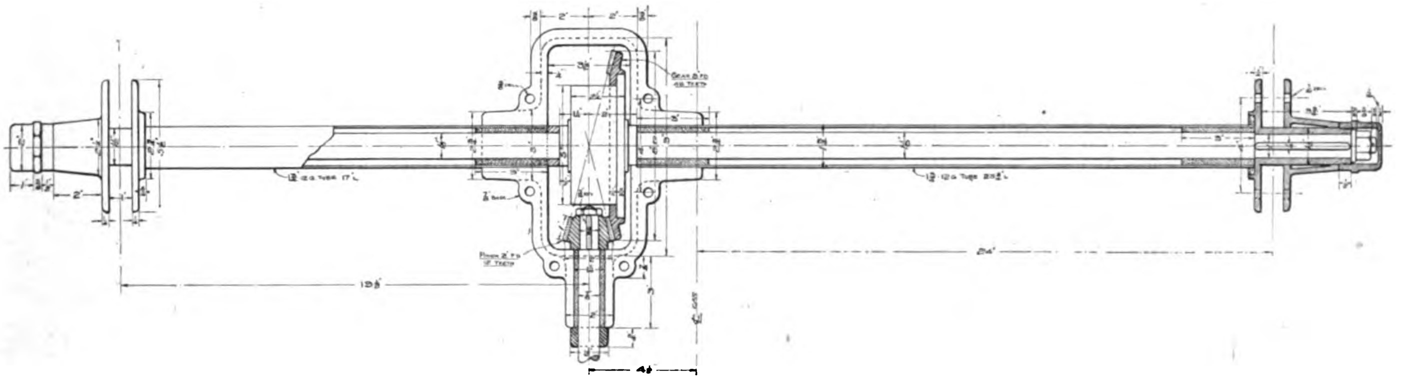


FIG. 18.—DETAILS OF REAR AXLE AND BEVEL GEAR.

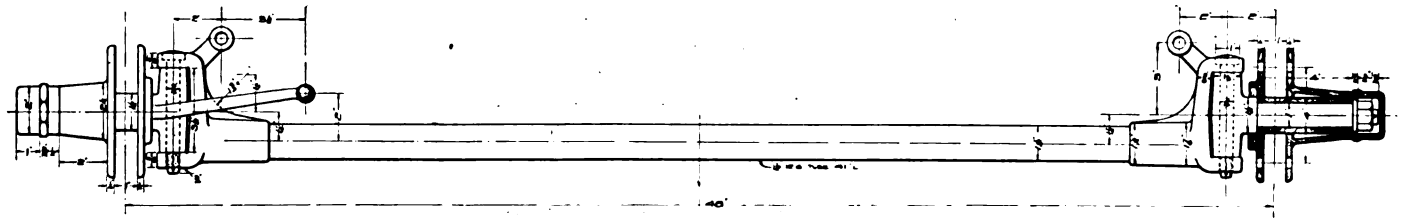


FIG. 20.—DETAIL OF FRONT AXLE.

for the rear axle. This consists of a steel casting which is bored to fit the axle tube and is clamped thereto and to the spring by means of a pair of ⅜-in. "U" bolts.

Fig. 20 shows the construction of the front axle and hubs. The axle consists of a length of 1½-in. tube brazed into the forked steering ends. The front hubs are the same as the rear ones, with the exception, of course, that they are bored a running fit for the axle instead of being keyed on. Further details of the axle ends can be obtained from Fig. 2. Fig. 21 shows the reach fitting for the front axle. This is bored to fit the front axle tube and the reach is intended to be a turning fit for the lower portion so that the running gear may adjust itself to any unevenness of the road. The reaches consist of a pair of steel tubes, the location and length of which may be seen in Fig. 1. They have solid ends brazed in and a nut is placed on the outside.

Fig. 22 shows the construction of the steering column. The tubular portion is stationary and has attached to it near the top the spark and throttle levers; the center rod turns with the hand-wheel and operates the screw at the bottom. The screw is 1⅛ inches outside diameter and has three threads with a pitch of one thread per inch. The proportions of the linkage are such that about one and one-half revolutions of the hand-wheel are required to turn the front wheels from one extreme to the other.

Figs. 23 and 24 show respectively the clutch, release pedal and the forked lever for disengaging the clutch. The latter has a pair of small rollers on the forked ends, which engage the grooved collar on the clutch shaft for drawing the cones apart. Fig. 25 shows the brake pedal. This, as well as the clutch pedal, should preferably be a steel forging. Fig. 26 shows the brake shoe, which may be a casting of alzinc and is faced with leather for the friction surface. This may be secured to the metal surface of the shoe by means of shellac and a considerable number of wooden shoepegs. The wear on this facing will probably be rapid, but it can be easily and cheaply renewed.

TELEPHONE TRAFFIC DEPARTMENT METHODS.

BY CHARLES H. COAR.

Time was when the traffic department of a telephone exchange was considered of minor importance, and no great efforts were exercised to ascertain the condition of the exchange service; whereas to-day it is considered of the utmost importance if efficient results are to be obtained from the operating staff.

Considering the fact that the wages of the operating staff constitute a principal item of expense in exchange maintenance amounting to approximately $3 per telephone a year in a modern central energy system of 5000 subscribers, one ceases to wonder at what possible benefits could accrue from the seemingly insignificant data obtained by the traffic department.

Good service in a telephone system can only be had when good transmission, reliability, promptness and civility exist, and none of these qualities could be dispensed with without a decided detrimental effect. Good transmission is necessary, of course, if service is to exist at all, while reliability, promptness and civility can be considered of relative importance. Assuming that efficient apparatus is installed, these last three qualities will be found to depend on the selection, training and management of the operators, and incidently on the conditions imposed.

The selection of girls for positions as operators should be done by persons with ability to read character, and by a woman, since she can request information without causing embarrassment.

It is not advisable to accept girls under 18 or over 25 years of age, and all applicants should furnish references as to past employment, and if upon examination they fulfil the necessary requirements such as sight, hearing, voice and reach, a record should be kept of each applicant containing the address and other desirable information concerning the applicant's examination, character and impression, together with the date of application.

These records form a handy reference and enable the traffic department to summon such candidates as are deemed desirable when necessary.

Certain traffic departments of the larger exchanges have spared no expense in obtaining the best facilities for training their operators, and the results obtained seem to justify the expense.

A successful applicant should first be taught the rudiments of the telephone, so as to know the difference between a transmitter and a receiver, what is meant by the terms used in the operating room, how to handle the cords and plugs in making a connection, how to converse over the telephone, and also how to become ambidextrous. This latter is a feature that is especially noticeable in many of the larger exchanges by its absence. Operators who are supposed to be perfect, will be found imposing on their right arm, while the left is used only in cases of necessity.

When the applicant is sufficiently trained in the rudiments, she may be placed at a position, having a receiver provided for her which is connected with the regular operator's set at this position, and in this manner she should soon become familiar with the requests of subscribers and the methods used in answering and making connections. She may then be allowed to operate a dull position under the supervision of a regular operator, until such time as she is thought to be competent to operate a position unaided. A night shift is usually assigned to her, then the future of course depends wholly on her own ability.

Applicants who have been previously employed as operators in small exchanges, as a rule, do not become good operators in a large exchange, for it is characteristic of this class to believe themselves fully competent, so that they view these preliminaries as needless. Persons well versed in traffic department methods consider it much more preferable to school their operators from the raw material, so as not to have any predetermined opinions or methods on the part of applicants to contend with.

Civility is one of the essential qualities required of a competent operator—that trait of being able to turn away wrath by a soft answer. Nagging and scolding of operators by the monitress should not be tolerated.

If at any time it becomes necessary to severely criticise an operator, it should be done so that the remaining employes will not hear the conversation. Many good operators become nervous every time a monitress stands near them, for the reason that they have formed the idea that a monitress is there to note all their deficiencies, and for this reason some lenience should be shown the operator, in accepting a monitress's report. When a monitress observes a position being nicely operated, there should be no hesitation on her part in informing the operator at this position of the fact; for the praise thus bestowed will make itself evident in the renewed efforts of the operator to please.

Everything taken into consideration, the idea of compensating the operators according to their service tests is a good idea, but it is not advisable to hold back part of their salary in case the service test is poor. The employe should know she is to have a certain amount due her on pay day regardless of the service test, which if excellent should be rewarded by a slight increase for this particular month. The matter of wages and extra compensation for good service tests must necessarily be confined to local conditions.

In an exchange where the service is strictly unlimited on party lines, it is customary in practice to expect a competent line-position operator to be able to complete about 200 calls per hour, but this is true of only certain positions during their busiest hours. In making this statement only the modern central-energy switchboard is considered.

Cases are said to be on record where a line-position operator completed 500 calls in one hour and a trunk operator 1000 calls in the same period.

In exchanges where the service consists of individual, party, measured and pay-station lines, it is generally conceded that the completion on an average of from 170 to 190 calls per hour is good operating. There are systems in which automatic counters are inserted in the cord circuits, which tend to lighten the operation of measured service lines, but in the majority of exchanges having this class of service either slips are recorded by the answering operator or a register is operated by the calling subscriber at his instrument. Where this class of service exists the operating would be necessarily slower. It becomes necessary at times in enchanges having several classes of service to distribute a portion of each kind of service throughout the different operating positions, in order that no particular position will be difficult for one operator to handle. It is usual, however, to classify the subscribers' numbers as much as possible with the kind of service they have, allotting the lower numbers to the individual service. By means of the peg count, information relative to this distribution is obtained, which enables the traffic department to distribute the lines in such manner as to give the best possible results.

By peg count is meant the recording of all calls occurring in an exchange for a period of twenty-four hours, in such manner that the total number of calls occurring at one or all the positions may be ascertained for this period. It is customary in most exchanges to have a peg count in the earlier part of the month, between the 5th and 15th, from 12 to 12. In making a peg count the operators record the calls either by pencil and paper or by moving a peg in the jacks, or by a small tabulating meter, which is the quickest as well as most convenient. An individual meter, operated mechanically, is provided for each operator. It has occurred to the writer that a small tabulating meter, such as could be fastened and operated in the palm of the hand, would be very convenient for this purpose, if properly constructed. The calls could then be recorded during any of the customary movements used in operating, say by a thumb pressure of the hand containing the meter, thus doing away with the extra movements now required in most methods.

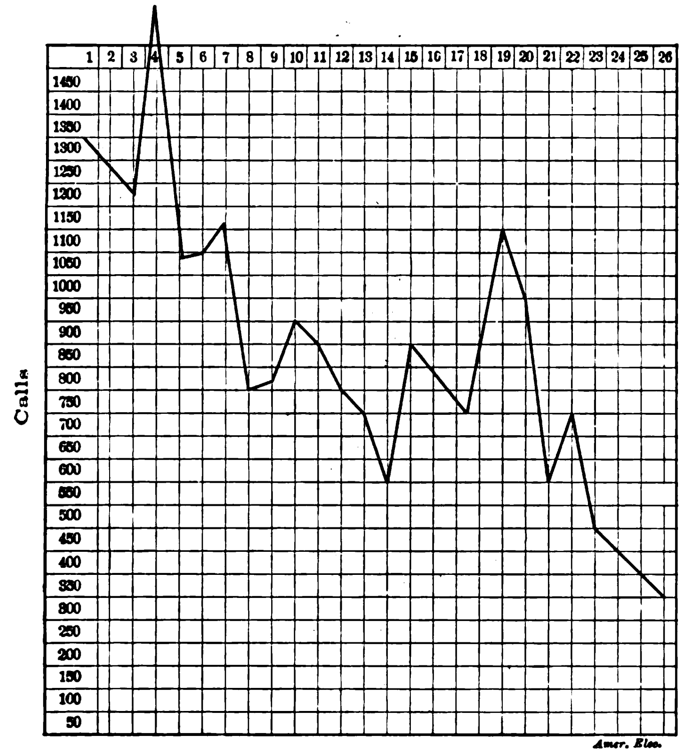


FIG. I.—PEG COUNT FROM EXCHANGE OF 2200 SUBSCRIBERS.

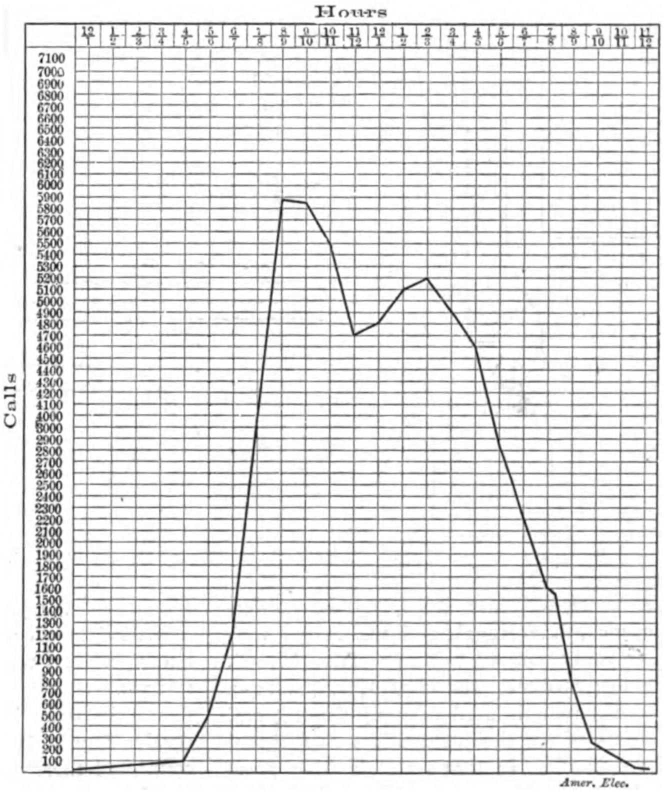


FIG. 2.—24-HOUR CHART SHOWING TOTAL CALLS RECEIVED.

After obtaining the number of calls at each section for the period of twenty-four hours, a curve is plotted, as shown in Fig. 1, which is useful in determining what positions are overcrowded or otherwise.

It has been demonstrated many times that one-eighth of the total number of calls occurring at a position during twenty-four hours is approximately the number of calls occurring at that position during its busiest hour, and the same proportion applied to the calls of the entire switchboard gives fairly good results in ascertaining the total number of calls during the busiest hour.

The curve shown in Fig. 1 gives the number of calls answered at each position for a period of twenty-four hours, the numbers at the top designating the different positions, while the figures in the left column represent the number of calls. The heavy black line is termed the load curve, and it is by plotting this curve that the positions overcrowded or otherwise are plainly shown.

It will be noted that a very poor distribution of lines existed where this peg count was taken, for it will be seen that there occurred at the first position approximately 1350 calls during the twenty-four hours, at the fourth position 1600 and zigzaging throughout the different positions to the small number of 400 calls at the twenty-fifth position. This exchange had about 2200 subscribers at the time this peg count was taken, with a total number of calls as compiled from the chart of 22,600, thus allowing slightly over 10 calls per telephone during twenty-four hours, which is found to be a fair average in general practice. By properly distributing these total calls, sixteen operators would be quite sufficient for efficient operation during the busiest hour, and quicker service would result, for dull position gives slow service, because it is very noticeable that an operator at a dull position gives slow service because she has not enough calls to complete, which would tend to make her alert and active. It is customary to find the first sections in a switchboard crowded, while others have hardly any lines.

Where this condition exists, the traffic department plans a distribution of the lines, causing the operators to have a mixed class of service to answer, that is, business and residential lines, for in this manner the load is more evenly distributed throughout the board, resulting ofttimes in diminishing the operating force, as well as increasing the efficiency of the service.

The chart shown in Fig. 2 is compiled from the peg count of an exchange of 5000 subscribers, and shows the total number of calls occurring in the exchange during any of the twenty-four hours in which the count was taken. The numbers in the space provided at the top represent the individual hours, starting from 12 to 1 a. m. at the extreme left and reading by hours to 11 to 12 p. m., space being provided for twenty-four hours, while the figures in the left column designate the number of calls. The heavy black line shows the disposition of the calls answered. Thus during the busiest hour, which occurred, as shown, between the hours of 8 and 9 a. m., the total number of calls answered was 5900, while during the dull period or midnight but a few calls were answered. In some exchanges, the dull period occurs between the hours of 2 and 4 a. m.

Charts of this description bring out much clearer the particular needs required for the betterment of the service than a column of figures, and upon filing these charts away, a ready means of comparing the results of the different months is obtained.

A great many different methods are used to secretly test the operator's ability and manner of answering subscribers, consisting mostly of circuits so designed that the person doing the testing may listen on the operator's set without her knowledge. These circuits terminate in jacks at the chief operator's desk, in many instances, where a special receiver, ranging from 2500 to 5000 ohms in resistance, is used in listening. It is necessary to employ a high resistance receiver, because most operators' hearing is very acute, enabling them to know when any one is listening on their set by the change in sound, which is not appreciable when a high resistance receiver is applied thereto.

In order to get a fair test of the subscribers' service it is necessary to select a group of lines and observe them during a certain period of the day. The number of groups and lines would be determined by the size of the exchange, but a fair portion should be selected so as to give a good average of the general service.

The circuits shown in Fig. 3 illustrate a test which is very efficient and also applicable to most systems from the intermediate rack. In Fig. 3 the circuit *A* represents the subscribers' line, multiple jack, answering jack, line signal, and the relays with their connection to this apparatus through the intermediate rack clips 1, 2, 3 and 4. The *B* circuit is used to apply the test and consists of the flexible conductors 1, 2 and 4, terminating in snaps and binding posts preferably as shown, and a jack having connected to its inner or rest contacts a 1000-ohm drop and a condenser in series; also a line signal lamp, a high resistance receiver terminating in a plug, and the receiver jacks and connecting cord. From fifteen to twenty-five of such circuits shown in connection with the flexible conductors 1, 2 and 4 may be mounted similarly to a small switchboard for convenience in handling. One receiver with the jacks and connecting cord would of course suffice for this group. This group of circuits may then be connected to an equal number of lines at the intermediate rack, by means of flexible conductors and snaps, applying the numbered snaps to the corresponding rack spring.

The different line signals of this group are supplied by a common terminal with sufficient current to light them, but this could easily be obtained at the rack. The subscribers' line numbers which are selected for testing should be recorded as they are connected to the test set, in order that the person doing the testing will know what line numbers are connected to the various test circuits.

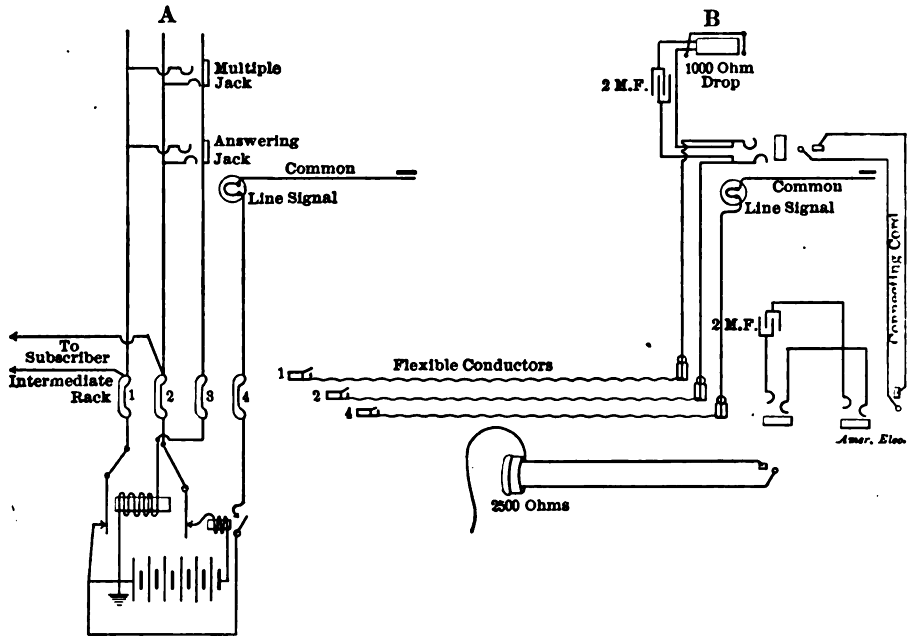


FIG. 3.—DIAGRAM OF TESTING CIRCUITS.

Assuming the lines connected, it will be evident upon tracing the circuits shown in Fig. 3 that as soon as one of the connected subscribers removes his receiver, the switchboard line lamp and the corresponding test circuit lamp will both light, and when the answering operator inserts a plug into this switchboard jack, both lamps will be extinguished, owing to the operation of the cut-off and line relays in the customary manner. The person doing the testing will thus be able to ascertain when one of the connected subscribers desires central, and by plugging the high resistance receiver into the proper jack can collect the desired data concerning the time consumed and operator's manner of making the connection.

The drops in the test circuits are used to receive any calls occurring over the lines connected thereto, enabling the person doing the testing to collect data concerning the manner of ringing subscribers, and other data such as could be obtained by listening on these circuits. The circuits being simple should present no difficulties, whatsoever in securing a fair test of the exchange service in general.

Circuits similar to these can be installed at the chief operator's desk, and complaining subscribers may be connected to them, for the purpose of bringing these lines under direct observation of the chief, in order that she may observe their service during complaints.

A variety of opinions exist regarding the length of time it should take for an operator to request "Number," after the subscriber's signal is shown, but in most systems an average of three seconds is considered good, although in many instances where comparatively easy operating exists, the elapsed time is even shorter.

A form having space provided for the following data concerning 50 or 100 lines will be found useful in recording the results obtained by using the circuit described.

a—Number of line.
b—Time of calling.
c—Time consumed by operator in inserting plug.
d—Time consumed by operator in requesting number.
e—Words used.
f—Number of subscriber called for.
g—Time called for subscriber's answer.
h—Length of conversation.
i—Time consumed in taking down connection.
j—Time consumed in reporting line busy.
k—Time consumed in reporting don't answer.
l—Time consumed in reporting out of order.
m—Manner of ringing.
n—Call lost.
Totals and average.

If these items are properly filled out and an average taken, a fairly accurate report of the services in general is obtained, although space is only provided for the more important operations.

A CONVENIENT LAMP BANK.

BY GEO. T. HANCHETT.

A portable resistance which is readily renewable and subdivided into units, may easily be made from a bank of incandescent electric lamps; and by the employment of lamps of the bung-hole type, such a bank can be made exceedingly compact. The lamps are preferably placed in a box equipped with binding posts and a carrying handle and hinged so that the top and sides can be opened when the bank is in use so as to rapidly dissipate the heat developed.

The accompanying illustration shows a bank of eighteen 16-c.p. lamps arranged in two rows. These may be connected either in series or in multiple on a two-wire or a three-wire system, and the actual resistance of either row varied by unscrewing a suitable number of lamps.

The applications of such a device are so numerous that it would be out of the question to mention them all, but some of the most important follow.

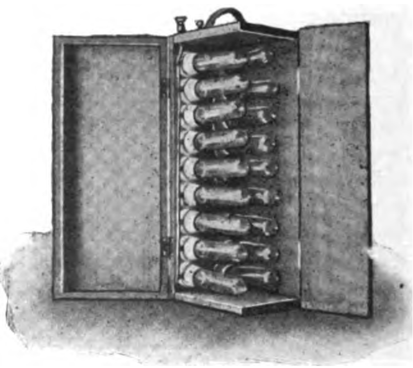


FIG. 1.—LAMP BANK.

As a load for small meters the apparatus is most convenient, since it can be applied to either two or three-wire meters and is always under control. In cases where it is desirable to test a large three-wire meter with the neutral wire disconnected and without interfering with the regular commercial load of the meter, such a bank connected in series across the line as a supplementary load (the neutral wire beyond the meter being connected to a neutral point in the lamp bank) is very useful, permitting any discrepancies in the balance of the load to be compensated for by the addition of a suitable number of lamps on the slightly loaded side.

The only suitable way to test the resistance of motor armatures is to cause current to flow through them and measure the drop with a low-reading voltmeter. The available current, however, must be used in connection with a resistance so as to be under control, and a lamp bank of this description is exceedingly convenient and suitable for the purpose.

In designing a field rheostat, especially for motor control, the lamp bank is very convenient for preliminary investigations. By connecting it in series with the field and adjusting the number of lamps in circuit, the limits of speed variation under which the motor can safely operate may be readily found, and an ammeter and voltmeter give the necessary data for a rheostat which will duplicate the results. The cost of making such a lamp bank should not exceed $7.00. It forms a very convenient adjunct to any testing laboratory, and is capable of consuming over a kilowatt. It should preferably be equipped with four watt lamps.

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WATER COLUMNS AND LOW WATER ALARMS.

BY R. T. STROHM.

In most places where stationary boilers are installed, it is not convenient to attach the gauge cocks and the gauge glass fittings directly to the shell of the boiler, and yet have them in plain view, or within easy reach, of the fireman. The most common method is to attach both to a separate and distinct fitting called the water column, as illustrated by Fig. 1. The water column, *A*, consists of a cylindrical iron casting, about 4 inches in diameter on the inside, on an average, though it may be as small as 2½ or as large as 5 inches in internal diameter. The thickness, of course, depends largely upon the pressure to which it must be subjected, but owing to the fact that cast-iron is a very unreliable and treacherous material when subjected to tension, the thickness should be ample, with a large factor of safety. This cylindrical column, *A*, is tapped both at the top and at the bottom to receive wrought-iron nipples, *B* and *C*, which connect with the pipes *D* and *E* leading to the steam space and the water space of the boiler, respectively.

These fittings and pipes are all made large, for a very good reason. The water column is intended to give reliable evidence as to the height of the water in the boiler, and in order to do so, its connections with the boiler must be free and open. All feedwaters contain sediment or scale-forming substances, and these, in the process of circulation, are deposited in various parts of the boiler and in pipes leading into it. A clogged water connection to the water column would, of course, render the readings of the gauge glass and the indications of the gauge cocks wrong and unreliable. Hence the use of large pipes, to prevent any such occurrence, within a reasonable length of service. If, however, the column is continually neglected, no care being taken to blow it out at intervals, the bottom connection must eventually clog up. To obviate the necessity of removing the entire column and its connections, in such a case, to permit proper cleaning, a cross, *F*, is used to connect the nipple, *C*, and the pipe, *E*. In the opening opposite the pipe, *E*, a plug, *G*, is screwed, which can easily be removed. Should the boiler connection become filled with sediment, the plug, *G*, is taken out and an iron bar pushed through the pipe until the passage is free from obstruction. A blow-off valve is placed on the pipe, *H*, and the frequent use of this should serve to prevent dangerous deposits of sediment in the water column or in the nipple, *C*.

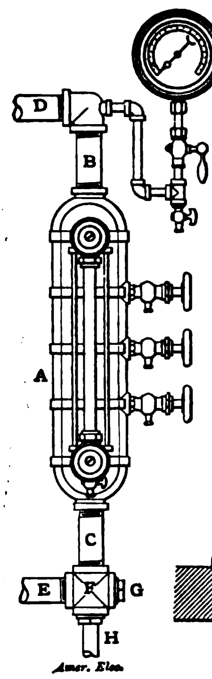

FIG. 1.

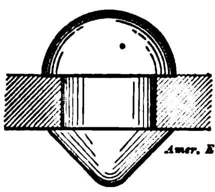

FIG. 2.

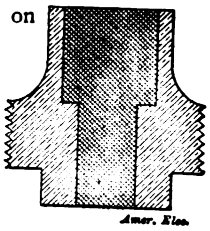

FIG. 3.

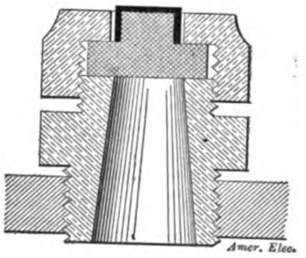

FIG. 4.

The water column is tapped to receive the gauge glass fittings and the gauge cocks. These appurtenances are usually placed in planes at right angles to each other, as indicated, the gauge glass being at the front. It is also customary to tap the column on both sides, so that the gauge cocks may be placed either to the right or to the left of the glass, according to the location of the boiler. The steam gauge is attached to the upper pipe fitting by a ¼-in. pipe so arranged that it may be easily drained or blown out. Draining becomes necessary if the boiler is to stand idle during very cold weather.

It is one of the many duties of the fireman to maintain a safe, and likewise a nearly constant, water level. However, numerous other matters demand his attention, and under these circumstances it is found that the water level in many boilers fluctuates considerably and frequently reaches the danger point. Low water is acknowledged to be a fruitful source of boiler explosions, and to prevent explosions due to this cause, and also to warn the attendant when the water approaches or reaches the danger level, numerous safety devices and alarms have been attached to steam boilers.

Doubtless the simplest of these many precautionary appliances is the fusible plug. It consists of a plug having a core of tin or lead, or of some alloy having a low melting point. This plug is screwed into the shell of the boiler at the lowest safe water level. So long as the plug is covered with water, the heat from the furnace or from the furnace gases is conducted away as rapidly as it is received. But if the water level falls so as to uncover the plug, there is no means of removing the heat, and the soft metal fuses, the pressure inside the boiler forcing out the molten metal and thus forming an outlet for the escape of the steam. This escape of steam calls attention to the fact that the water has reached the danger level.

One method of inserting the fusible plug is illustrated by Fig. 2. A hole about ½ inch in diameter is drilled in the plate, and a rivet of lead or composition metal is driven in and headed. This form is not easily replaced when it has blown out, however, and in this respect the plug shown in Fig. 3 has the advantage, since it may be replaced from the exterior of the boiler shell. As illustrated, it is simply a brass plug, having a center of fusible alloy, screwed into the plate. If it should melt, the empty brass shell is removed and a new plug substituted. In case the water contains corrosive impurities which may affect the soft metal in the plug, it becomes necessary to use a protective cap, as shown by the plug in Fig. 4. In this form, the fusible portion is a button or disc held firmly between the plug body and a removable screw cap. Over the top of the button is placed a thin copper cap which effectually prevents contact of the water and the fusible alloy. Since the top of this plug is considerably above the plate surface, it will give the alarm before the water actually uncovers the plate, thus preventing overheating and bulging of the shell.

The fusible metals used in safety plugs are lead, tin, Babbitt, and alloys of cadmium. All of these have melting points considerably below the temperature of red-hot iron. The United States Supervising Inspectors specify that Banca tin shall be used in fusible plugs; its melting point is about 445° F. They also require the plugs to be at least ½ inch in diameter at the smallest end of the internal opening. The plugs are placed in the bottom of the steam drum in the water tube type of boiler, in the rear head of the return tubular boiler, above the upper row of tubes, and in the crown sheet of the locomotive and vertical types of boilers. They should be kept free from accumulations of scale, otherwise this may become strong enough to hold the pressure and prevent warning of the danger, even after the plug has melted out. On the other hand, a layer of sediment may prevent the water from absorbing the heat as it should, and may thus cause the plug to fuse when there is absolutely no danger. Inspectors are required to renew these plugs at each annual inspection; for the melting point of the fusible metal may change under the effects of the heat and the water, so as to make an old plug an unreliable device. Furthermore, it is not possible to test the fusible plug so as to determine whether it is at all times in condition to give the alarm in case low water should occur.

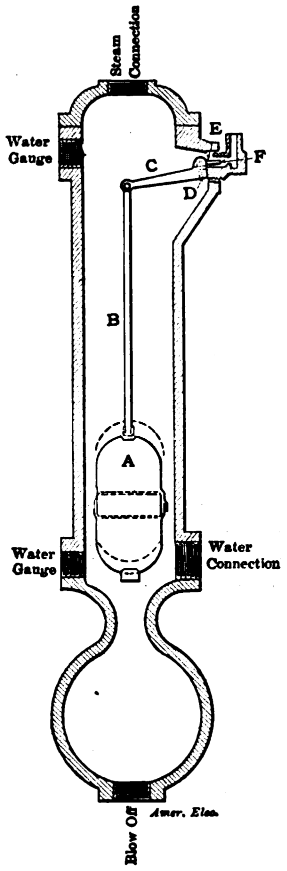

FIG. 5.

In view of these objections and difficulties, a class of safety devices known as low water alarms has been placed upon the market. The principles of construction and operation vary largely, but the alarm in Fig. 5 represents one of the most common forms of this apparatus. It consists of a cast-iron water column within which is placed an air and water-tight float, *A*, rigidly attached to a vertical rod, *B*, the latter being in turn connected to a bell-crank lever, *C*, pivoted at *D*. The short arm of the lever is attached to a tapering plug valve, *E*, which controls the opening, *F*, leading to a small steam whistle. When the water is at its normal level in the column, the buoyancy of the float, *A*, pushes the long arm of the lever, *C*, upward, and forces the plug, *E*, to its seat, closing the exit, *F*. Should the water level fall to or below the danger point, the float also descends and in so doing opens the valve, *E*, permitting live steam to escape through *F* and sound the whistle, thus calling the attention of the fireman or water tender to the fact that the water level is low. The whistle will continue to blow until the pump or the injector has been started and the boiler filled to or near its normal level.

The alarm just described, however, can give warning only in case of low water. There is danger also in carrying too high a level, since this may cause water to be carried over into the engine cylinder in such amount as to wreck the engine. The alarm shown in Fig. 6 is a combined high and low-water alarm. It contains two floats, each of which, through a connecting rod and lever, controls a valve leading to the whistle. When at normal level, the water is at such height as to maintain the float, *A*, in the position indicated by the dotted lines, and the float, *B*, in the position indicated by the full lines. If the water rises, the float, *B*, also rises and when the level reaches the top gauge cock the float, *B*, opens the valve, *C*, and gives the alarm. On the contrary, if the level falls much below the lower gauge cock, the float, *A*, falls to the position denoted by solid lines and opens the valve, *D*, also sounding the whistle. To keep the whistle silent, therefore, it is necessary to maintain a fairly constant water level in the boiler. It will be observed that each of these columns is provided with a spherical sediment chamber, which can be blown out by a blow-off valve attached at the bottom of the column. By opening the blow-off valve, the water level in the column may be lowered sufficiently to test the action of the low-water float, and this test can be made at any time.

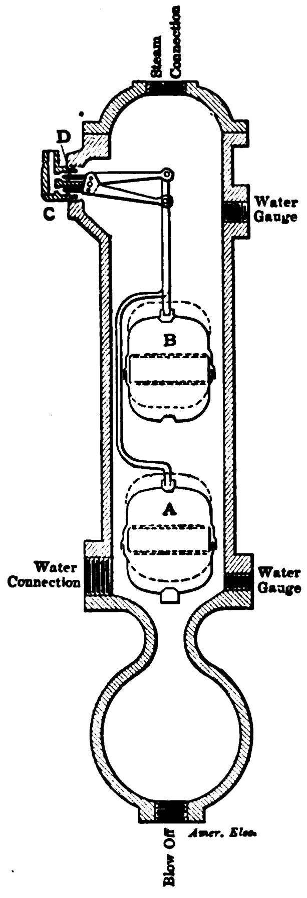

FIG. 6.

It is not necessary to have two floats for the purpose of registering both high and low water. These objects may be attained by the use of a single float, as in Fig. 7. In this type, there is a passage through the center of the float, *A*, allowing it to move up or down on the rod, *B*, according to the variation of the level. The rod is fitted with two nuts, *C* and *D*, one at each end, which may be screwed closer or farther apart, thus regulating the allowable limits between which the water level may fluctuate without sounding the alarm. The counterweight, *E*, pivoted at *F*, balances the weight of the rod, *B*, and its lever, *G*. The latter is pivoted at *H*. When the water level gets too high, the float strikes the nut, *D*, pushes the rod, *B*, upward and causes the lever, *G*, to fulcrum against the point *L*, which pulls the joint, *H*, and the plug, *M*, downward, admitting steam to the whistle through the ports, *N N*. If the level falls too low, the float, *A*, strikes the nut, *C*, pulling the lever, *G*, downward, so that its shorter end fulcrums at *Q*. Further downward motion of the rod, *B*, then opens the valve and sounds the whistle, as before. A valuable feature of this alarm is that all working parts are connected to the removable head, *R*, so that there is little difficulty in removing these parts for adjustment or repair. Another single-float alarm for both high and low water is illustrated by Fig. 8. In this case the float is rigidly attached to the rod, which moves up and down through a slot in the end of the valve lever, *A*. The adjustable collar, *B*, regulates the variation in water level through which the alarm will not sound. It will be seen that no matter whether the lever *A* be depressed or raised, it will raise the plug, *C*, since this lever may fulcrum at either edge of the block, *D*. Still another type of high and lower-water alarm is shown in Fig. 9. Instead of attaching the float to a rod, it is

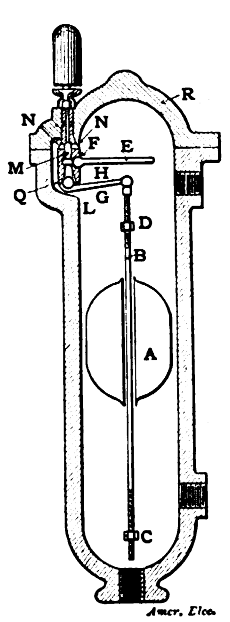

FIG. 7.

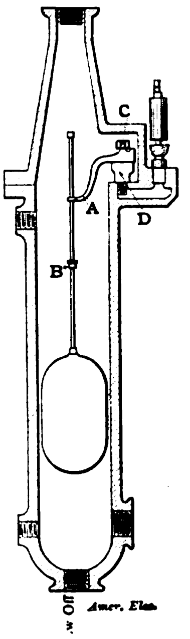

FIG. 8.

made spherical and is perfectly free of all connection with the remainder of the apparatus, floating at the surface of the water. The spherical shape offers the greatest resistance to the pressure from without. When the water level rises too high, the float presses against the curved diaphragm *A* attached to the lever *B* by the rod *C*. This motion of the lever opens the valve *D* and gives the alarm. A ring, *E*, also attached to the valve, *D*, by a rod, *F*, catches the float when the water level falls too low and is depressed by the weight of the sphere, thus opening the whistle valve. All of the working parts are fixed to the removable head.

The alarms previously described depend upon the buoyancy of hollow cylindrical or spherical floats for their action. Considerable difficulty and annoyance have been experienced by the leakage of these floats, and also by their collapse under the high pressures now carried in many plants. The introduction of seamless floats has prevented leakage trouble, but distortion due to pressure is not so easily overcome. A style of low-water alarm which obviates both of these difficulties is illustrated by Fig. 10. The whistle valve, *A*, is jointed to the lever, *B*, which is fulcrumed at *C*. To the left of the fulcrum a cast-iron weight, *D*, is hung from the lever, and at the extreme right is suspended a hollow cylinder, *E*, by the rod, *F*. This cylinder is perforated, near the top, by several holes, through which it is filled by the water in which it is immersed. So long as the water level remains above the lower danger line, the alarm is silent, as the moment of the weight, *D*, about the fulcrum, *C*, is greater than that of the submerged cylinder, *E*, thus keeping the valve, *A*, closed. Should the water level fall dangerously low, the cylinder, *E*, will no longer be wholly submerged, and its weight, together with the weight of the water it contains, will overbalance the effect of the counterweight, *D*, and open the whistle valve, *A*. The stop, *G*, prevents the descent of the cylinder, *E*, beyond a point necessary to open the valve, *A*, fully. The advantage of having all internal mechanism attached to the removable cover plate is observed in this alarm also.

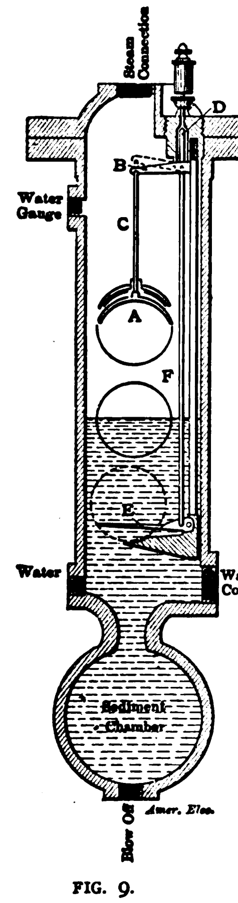

FIG. 9.

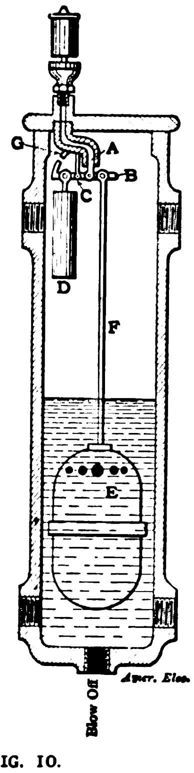

FIG. 10.

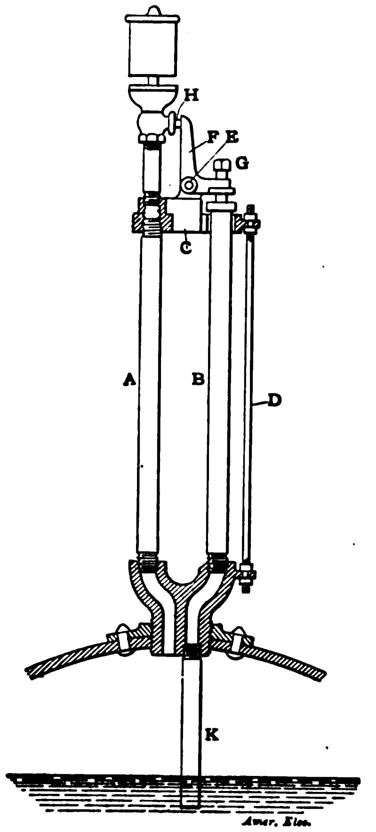

FIG. 11.

The use of two bars of different metals, having different coefficients of expansion, to operate various devices, has become quite common, and in Fig. 11 is illustrated a low-water alarm making use of the difference of expansion of two metals under the effect of heat. Two pipes, *A* and *B*, are connected to a cast-iron Y, which is screwed into the boiler shell above the water level. The pipe, *A*, which is of wrought-iron, serves to lead steam from the steam space to the whistle valve, and is rigidly attached to the cast-iron yoke, *C*. The pipe, *B*, of copper, has its lower end firmly screwed into the Y fitting. Its upper end is closed by a cap, and is free to move vertically up and down through a hole in the yoke, *C*. A tie rod, *D*, with adjusting nuts, serves to hold the yoke rigidly in place. Fastened to the yoke, *C*, is a short lug holding a pin, *E*, on which the bell-crank lever, *F*, is pivoted. The short end of this lever carries a set-screw, *G*, which rests against the cap on the pipe, *B*. The long end of the lever touches the stem, *H*, of the whistle valve. A pipe, *K*, whose lower end is at the lowest safe water level is inserted into the opening of the Y, which leads to the copper pipe, *B*. So long as the water in the boiler is above the danger limit, the end of the pipe, *K*, remains submerged, and the boiler pressure forces a column of water up into the pipe, *B*. Owing to the large radiating surface of this pipe, the water is comparatively cool. Should the water level fall below the end of the pipe, *K*, however, the water in the pipe, *B*, runs out, and the space is filled with live steam. The difference in temperature between the water formerly filling the pipe and the steam causes the pipe, *B*, to expand, pressing the set-screw, *G*, upward. This motion being transmitted to the short end of the lever, *F*, the longer end is forced against the stem, *H*, opening the valve and permitting the alarm to sound. The linear expansion of copper is slightly more than 1-10,000 of an inch per foot for each Fahrenheit degree increase of temperature. Consequently it may be readily seen that the movement of the lever will be very small, and that to keep the alarm in proper working order, it will be necessary to maintain very accurate adjustments of the parts.

The alarm shown in Fig. 12 makes use of the expansion of air as an agent by which to give warning of low water. The device is screwed into the water column in the place of the lower gauge cock, so that the chamber, *A*, is filled with water when the water level is normal, and this water is comparatively cool. Separated from the chamber, *A*, by a thin partition, *B*, is a closed chamber, *C*, one side of which is formed by the flat circular diaphragm, *D*. The chamber, *C*, is filled with air. When the water level becomes too low, steam enters the chamber, *A*. Its heat being transmitted through the wall, *B*, the air in chamber *C* expands, forcing the diaphragm outward, carrying the plug, *E*, with it, until it meets the end of the screw, *F*. This contact closes an electric circuit, and rings a bell which may be placed at any desired point. When sufficient water has been pumped in to raise the water level, the water in chamber *A* cools down, and the spring, *G*, returns the plug, *E*, to its former position.

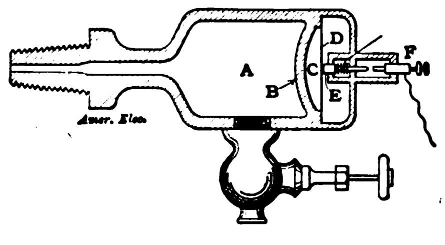

FIG. 12.

There are many advantages to be derived from the use of a good water alarm. It gives undeniable evidence of inattention or carelessness on the part of the boiler attendants, and since it can be kept silent only by the maintenance of a proper water level, the device encourages uniformity of working conditions. It has been argued that after a short period of working with automatic alarms, the firemen grow to depend wholly upon these attachments as a guide in feeding the boilers. While not altogether objectionable, this practice forms a strong argument in favor of alarms of absolute reliability at all times. Additional advantages of a steady water level are to be found in less leakage of tubes or seams due to unequal expansion, less danger of burned plates, and dryer steam.

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WIRING FOR FACTORIES, MILLS, ETC.

BY ARTHUR B. WEEKS.

Before beginning any wiring work, it is best to go over the course thoroughly to get the most direct route, eliminating all the turns possible, and saving all the splicing practicable. The run having been arranged, the cleats or insulators are located. Porcelain cleats can be used to advantage on cable as large as 300,000 circular mils and by properly spacing the cleats very little sag in the line will result. For cables larger than 300,000 circular mils special cleat insulators are used. At turns the insulators should be neatly arranged, and in open work with joists, 2 x 4's will be required on which to fasten the insulators. Where mill construction is employed, none need be used.

When boring through mill floor construction, where nails are hit promiscuously, it is best to bore with either a rachet or pneumatic drill. Much time will thereby be saved and many "bits" spared from being spoiled by nails. In crossing other wires, circular loom or porcelain tubes should be used, the loom or flexduct being preferable owing to the fragile nature of porcelain.

It is generally known that in running wires through walls or partitions porcelain tubes are required. In some cases tape will be necessary for holding a tube in place. Inside wiring should always be rubber core, and in some special places, fire and weather-proof. When passing into cellars and subways or under engine room floors and among steam and water pipes great care is required in running wires. As much clearance as possible should be allowed between pipes and wires, and no sag in the wires should be permitted. Pipes carrying oils and gasoline are sometimes run in tunnels built for them, and since nothing but an incandescent lamp can be used in such places, it is best to cut them in directly on the line, using no fuses at the lamp, but fusing the main outside the tunnel, and controlling all the lamps by a switch. A vapor-proof globe is the safest made. Too much care in this respect cannot be used, and where power wires tap a feeder in so dangerous a place as this, it is not wise to change the size of the wire; but the same size of wire as the feeder should be used to a point out of the danger district, where fuse blocks may be located.

In damp places porcelain weather-proof sockets should be used, and if there are inflammable gases, vapor-proof globes should be employed. One sometimes finds brass lamp sockets used in such places due to ignorance or gross carelessness. A well-paid electrician can save many times his salary in the course of a year, by taking care of just such things. A fire can be easily started from a blown fuse in a tunnel containing gases, or in one where gases are liable to escape.

Iron conduit can be frequently used to advantage through tunnels; and outlet boxes employed where there are taps. In running two-phase, alternate-current power lines, however, do not run a conduit for each wire; but insert the two wires of one phase in an iron conduit, using another conduit for the wires of the other phase. The underwriters may allow all four wires in one conduit; but the former practice will usually be found better.

Many ingenious methods are in vogue for securing wire supports through tunnels and in fire-proof buildings across and parallel to the girders. One thing should be uppermost in the wireman's mind when doing such work, and that is to secure perfect insulation. There are other important features much to be desired, such as neatness, symmetry and permanency; much wiring being done with the proverbial "lick and a promise," and never touched again. A joint is often made, and, no tape being at hand, is left for the indefinite future; a hurry job for a splice where a wire has broken calls for slipping the wire off an insulator to provide the requisite slack, and, instead of being properly attended to, the wire is left unsupported. At a furnace, the flames may have bared the conductors, and these are left for the future. A loose wire in the binding post of a motor has perhaps arced until a repair job is needed to put it in order; perhaps all it will get is a twist around the screws of the terminal. Loose screws in fuse blocks and blown fuses from poor contact often go unnoticed.

If changes in factories call for a change in wiring, the work should be made neat and permanent as soon as possible. Twenty feet or more of cable hanging loosely from a nail or hook on the wall, or over a peg on a post for a week or more, does not look business-like. In iron buildings for storing varnishes and oils, special care should be required, and no fuse whatever allowed at individual lamps. Vapor-proof globes should be used in all dangerous places, and porcelain weather-proof sockets in damp ones. Lights should be located so that when the lamp is carelessly left to swing, it will not strike against tanks, girders or wall, or else guards should be fitted for these sockets.

Wiring for outside work should be substantially done, especially if wires enter buildings at points where ice is liable to accumulate on them, or where falling ice strikes them. This is often overlooked, with the result that wires break or become grounded. The wires should be secured so that it will be impossible for them to be pulled against the iron work of a building. Special work is sometimes necessary. They should have a firm support inside the building and if they leave the building at an angle, a support is also necessary on the outside. It is sometimes more convenient and less expensive to run feeder wires on the outside of buildings instead of carrying the wires through from various rooms, making numerous turns to avoid shafts and belts and other obstructions.

To fasten wires along a brick wall, 2 x 4's can be fastened to the wall and the insulators fastened to these, or the wall can be plugged and malleable iron wall brackets fastened directly to the wall. Double petticoat glass insulators should be used for this work, and not porcelain knobs. Rubber core wire should not be used for outside work, as it is not intended for this work and is not durable. Outside work of this kind requires good weather-proof wire, and should the wiring be around boilers, blast furnaces, etc., where there is great heat, fire-proof as well as weather-proof wire will be needed.

While No. 14 wire might be amply large for use in these places, it is best to use No. 12 or even No. 10, since mechanical strength should be the first consideration. In work of this kind where there is no fire risk, taps for drop lights can be made with No. 14 fire and weather-proof wire directly, without fused rosettes. The lamps in the circuit, however, should be controlled by a switch, and the main fused. If the switch and cut-out block, or fused switch, are out doors, a convenient box can be made and secured to an iron column within reach of the ground. Arc lamps in the vicinity of blast furnaces should be raised and lowered by means of ¼-in. iron cable, and so located as to be least effected by heat and escaping gases.

Lessons in Practical Electricity

THE TRANSFORMER.

As explained in an early lesson, the passage of a current through a wire coiled about a bar of iron or steel will magnetize the bar. If the magnetizing current be alternating, the magnetism in the bar will be alternating: that is, the polarity of the ends will alternate in accord with the alternations of the magnetizing current. As the magnetizing current rises from zero to maximum in one direction, the magnetic flux in the bar rises from zero to maximum in the corresponding direction, and as the current dies away to zero again, the flux dies away. Now, if a second coil be wound about the bar, the rising, falling, reversing, etc., of the magnetic flux will induce in this second coil an e.m.f. which will rise, fall, reverse and rise, fall, and so on, in response to the variations of the flux. The elementary form of such an arrangement is indicated in Fig. 1, where a round iron bar is shown wound with a primary coil, *P*, which is supplied with current from an alternating-current generator, and a secondary coil, *S*, in which an e.m.f. is in-

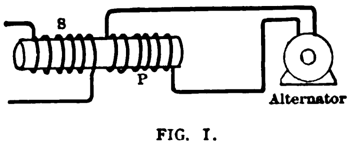


FIG. 1.

duced by the varying magnetic flux produced by the current in the primary coil.

In an arrangement such as that shown in Fig. 1, the magnetic flux would have to complete its circuit through air from pole to pole of the bar, and the flux produced by a given magnetizing current would be relatively small on account of the high reluctance of the air path. With a continuous core, as indicated in Fig. 2, the flux would be much greater, and a given magnetizing current in the primary coil would produce a much higher e.m.f. in the secondary coil, the induced e.m.f. being exactly proportional to the flux strength, as in the case of a dynamo. If the coils were arranged as indicated in Fig. 2, however, part of the magnetic flux produced by the primary coil would pass around the coil through the air instead of the other leg of the core, as indicated roughly by the dotted lines in Fig. 3, and these would not only be wasted so far as inducing secondary e.m.f. is concerned, but they would increase the self-induction of the primary coil and thereby reduce its activity. In order to reduce this magnetic leakage to the smallest degree it is customary to wind one coil over the outside of the other, as shown in Fig. 4, so that practically all of the magnetic lines of force set up by the primary winding will "cut" across the convolutions of the secondary winding as they expand and collapse from and toward the center of the iron core. Even with this arrangement, there is a little leakage of magnetic lines through the insulating material between the two coils (represented by the heavy line in Fig. 3).

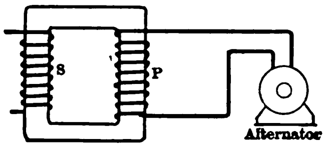


FIG. 2.

The relations between the primary winding, e.m.f. and current and the secondary winding, e.m.f. and current are roughly as follows:

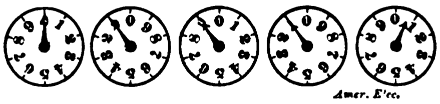
$$\frac{Pri\ e.m.f.}{Sec.\ e.m.f} = \frac{Pri.\ turns}{Sec.\ turns} = \frac{Sec.\ current}{Pri.\ current}$$

The expression $\frac{Pri.\ e.m.f.}{Sec.\ e.m.f.}$ is termed the transformer ratio, or ratio of transformation. It is some times convenient to represent it by a symbol, k_t. Then the relations between the windings, e.m.fs. and currents may be indicated very concisely by means of simple formulas, thus:

$$E \div k_t = e$$
$$N_t \div k_t = n_t$$
$$I \times k_t = i,$$

the capital letters representing primary e.m.f., number of turns and current while the small letters indicate corresponding secondary values. These formulas are only approximately accurate, for reasons that will be explained more fully in the next lesson. Reduced to plain English they mean: That the secondary e.m.f is approximately equal to the primary e.m.f. divided by the ratio of transformation; that the secondary current is approximately equal to the primary current multiplied by the ratio of transformation, and that the requisite number of secondary turns is approximately equal to the number of primary turns divided by the ratio of transformation.

The starting point, however, is the applied primary e.m.f.; this is always the first known quantity, and upon it depends the number of primary turns for a given transformer capacity. The size of the core, and consequently the magnetic flux, also affects the number of primary turns. The counter e.m.f, of the primary winding (due to self-induction) is so nearly the same as the applied e.m.f. at the primary terminals that the two may be considered equal for purposes of rough analysis. This e.m.f. is given by the equation



TRICKY METER READING.

$$E_t = 4.44\ f\ \Phi\ N_t \div 100{,}000{,}000$$

in which f is the frequency of the supply e.m.f. in cycles per second and Φ is the magnetic flux produced in the transformer core. The amount of magnetic flux in the core is limited, practically, by the size of the core cross-section. Hence, the size of core has a direct bearing upon the number of primary turns. The size of the primary conductor also has an important bearing upon the number of turns for the reason that the space occupied by the winding must bear some relation to the size of the core, and only so many turns of a given size of wire can be got into a given space. Since these are features of practical design, and do not affect fundamental operating principles, they will not be analyzed here.

The e.m.f. induced in the secondary winding by the magnetic flux is ascertained by exactly the same formula as the primary induced e.m.f., substituting primary values, thus:

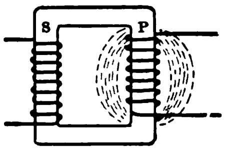


FIG. 3.

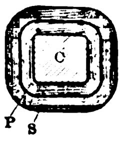


FIG. 4.

$$e_t = 4.44\ f\ \Phi\ n_t \div 100{,}000{,}000$$

from which it will be evident that the relations between the primary and secondary *induced* e.m.fs. and conductor turns are accurately given by the formulas which give approximately the relations between *terminal* e.m.fs. and turns. The relations between terminal and induced e.m.fs. will be explained in another lesson, along with other phenomena involved in transformer operation.

Letters on Practical Subjects

Mr. Bennett's Meter Reading.

To the Editor, American Electrician:

Referring to Mr. Bennett's tricky meter reading in the June number, I submit 91,000 as the reading, assuming that the right-hand dial is calibrated in hundreds (a complete revolution = 1000). Beginning at the right, the pointer is between 0 and 1 and therefore reads 0; the next pointer is at 1 and the middle pointer is at 9. The pointer of the dial next to the left appears to be at 1, but it cannot have reached that figure until its right-hand neighbor reaches *O*, so that it must be read *O* as the meter stands.

Canton, Pa. H. LEE CLARK.

[The same solution and explanation have been received from B. H. Barre, Bennettsville, S. C.; R. C. Barton, Alameda, Cal.; Wilfred S. Boult, Brooklyn, N. Y.; J. D. Cartin, Watertown, N. Y.; Uriah Davis, Chicago; C. F. DeRichmond, Ridgewood, N. J.; James B. Dillon, Louisville, Ky.; B. H. Elkins, South Windham, Me.; George A. Gould, Phillipsdale, R. I.; D. I. Gue, Chester, Iowa; C. S. Kaefle, Trenton Falls, N. Y.; Wilson A. McCown, Ladonia, Tex.; George Ocobock, Ovid, Mich.; Martin O'Connor, Milwaukee, Wis.; C. F. Richardson, West Minneapolis, Minn.; Albert H. Ryan, San Diego, Cal.; Philip C. Schools, Wardner, Idaho; Joseph E. Stenlake, Allentown, Pa., and A. V. Youens, Wilkinsburg, Pa.

The following readings, which are the same as Mr. Clark's except that the indication of the right-hand pointer is estimated, have also been received: 91,033 from W. M. Aiken, Bennington, Vt.; 91,050 from Arthur Barthels and Robert Young, of San Francisco (independently); 91,060 from J. P. Jones, Cedar Falls, Iowa, and Ralph Ryder, New York; 91,066 from Fred J. Ruffey, Rochester, N. Y., and L. A. Schultz, Craftonsville, Cal.; 91,075 from C. M. Green, Conneaut, Ohio.—EDITOR.]

◆

An Unusual Potential Wire Effect.

To the Editor, American Electrician:

We are operating a three-wire, 220-volt system with potential wires from the center of distribution back to the station voltmeter. Sometimes the voltage on one side of the neutral wire is higher at the center of distribution than it is at the station bus-bars: that is, the voltage between the neutral wire and one of the main wires is higher at the far end of the feeders than it is at the bus-bars. Can anyone explain why?

Canton, Pa. H. LEE CLARK.

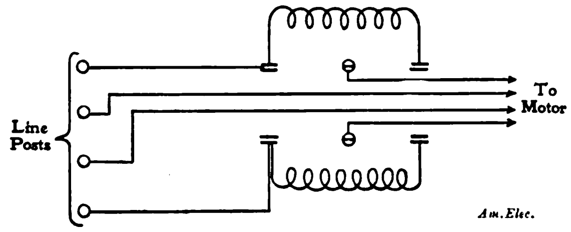
◆

An Emergency Induction Motor Starter.

To the Editor, American Electrician:

An autotransformer starting box used on

a 50-h.p., two-phase induction motor recently burned out, and as it was important that the motor should be kept in operation, I had recourse to the following simple expedient: Two pieces of No. 14 iron wire, each 100 feet long, were wound into spirals 4 inches in diameter and mounted on frames which were put into barrels and filled with water. The starting switch panel was then mounted on two timbers and located near the barrels, and the motor was connected to the improvised starter and the main line as shown by the accompanying sketch.



EMERGENCY INDUCTION MOTOR STARTER.

Although there is nothing new or original about this arrangement, it is described with the hope that it may be of interest to some readers of the AMERICAN ELECTRICIAN.

Mesa, Ariz. F. W. CERNY.

◆

A Commutator Trouble.

To the Editor, American Electrician:

The plant I am in charge of has two 45-kw., direct-current generators connected in the usual way to a three-wire system of distribution. The commutator of the dynamo on the positive side of the system gives trouble continuously by developing what seems to be a carbon burn extending around one-fourth of the commutator circumference, approximately. We have sandpapered the commutator, of course, a number of times; but after a couple of nights' running the blackening returns. I will appreciate any suggestions as to the cause of this trouble and the remedy for it.

Nogales, Ariz. V. P. MALONEY.

[Readers are invited to send to this office, for publication, suggestions concerning Mr. Maloney's commutator trouble. Such communications must be received here not later than July 15th.—EDITOR.]

◆

Those Needed Mirror Lamp Holders.

To the Editor, American Electrician:

In your June issue, under the head of "Some Things We Need," Mr. C. R. James calls attention to the need of a device whereby an incandescent light could be quickly and easily attached to each side of the mirror of a dresser. We have just this in our "Electrogrip." If Mr. James or any one else interested will send their address we will be pleased to send, without any cost to them, a sample of the device.

APPLIED DEVICE COMPANY.

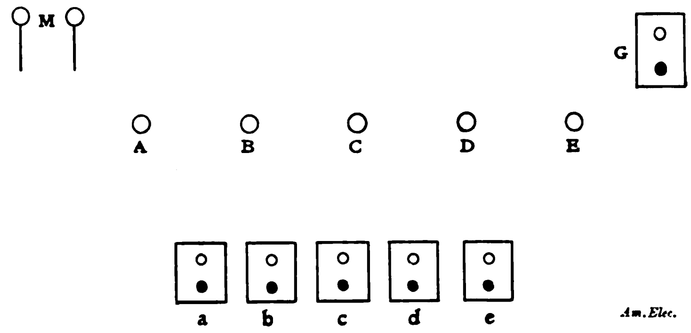
Springfield, Mass.

◆

Problem in Switch Connections.

To the Editor, American Electrician:

A problem in incandescent wiring came up in my work some time ago and I submit it for consideration by the readers of the AMERICAN ELECTRICIAN. Five outlets, located respectively in the kitchen, dining-room, parlor, hall and veranda of a residence, were to be wired for control individually by means of five flush push-button switches and collectively by means of a similar switch located in a bedroom upstairs. In the accompanying diagram, the outlets are represented at *A, B, C, D* and *E,* the corresponding individual switches by *a, b, c, d* and *e,* the gang switch by *g* and the main line entrance by *M.* The object, of course, is to make the connections with the least quantity of wire.



PROBLEM IN SWITCH CONNECTIONS

SAM L. LAUGHLIN.

Guelph, Ontario, Canada.

[Solutions for publication must reach this office not later than July 15th.—EDITOR.]

◆

Mr. Lincoln's Problem in Motor Circuits.

To the Editor, American Electrician:

The enclosed diagram (Fig. 1) is submitted as a solution of Mr. Lincoln's problem published last month. The two motors are connected to and disconnected from the supply circuits by means of a four-pole, double-throw switch, and reversed individually by means of the double-throw, double-pole switches *R1* and *R2.* When the four-pole switch is closed upward, the two motors are connected to the 110-volt circuit in parallel; when it is thrown downward, they are connected in series to the 220-volt circuit. The four-pole switch may readily be obtained by mounting two double-pole switches side by side and bolting a hard fibre bar across the two cross-bars of the switches, or substituting one long bar for the two shorter ones on the ends of the switch's blades. The two reversing switches, it may be noticed, are so connected to the motors and the starting boxes are connected in circuit in such a way, that no separate main switch is required for each motor; the leads from the reverse switch to the four-pole switch would be fused, of course, and each motor may be controlled by its reversing switch when the motors are on the 110-volt circuit. When they are on the 220-volt circuit, they cannot be controlled independently, of course, because they are in series.

Alameda, Cal. R. C. BARTON.

[C. E. Bryson, Chicago, and Martin O'Connor, Milwaukee, sent in solutions exactly like Mr. Barton's except that no starting boxes were shown on their diagrams. C. H. Pool, New York, sent a solution like the above except that no starting boxes were shown and the field and armature of each motor were transposed; that is, the armatures were connected to the middle posts of the reversing switches and the fields to the jaws.—EDITOR.]

To the Editor, American Electrician:

The enclosed diagram (Fig. 2) is submitted as a solution of Mr. Lincoln's problem. The motors are provided with individual reversing switches of the double-pole, double-throw type and are connected to either the 110-volt or the 220-volt circuit by means of a four-pole, double-throw knife switch. The motors should, of course, be protected by fuses; I omitted these because they have no bearing on the problem as it was stated.

Barre, Vt. HAZEN CLARK.

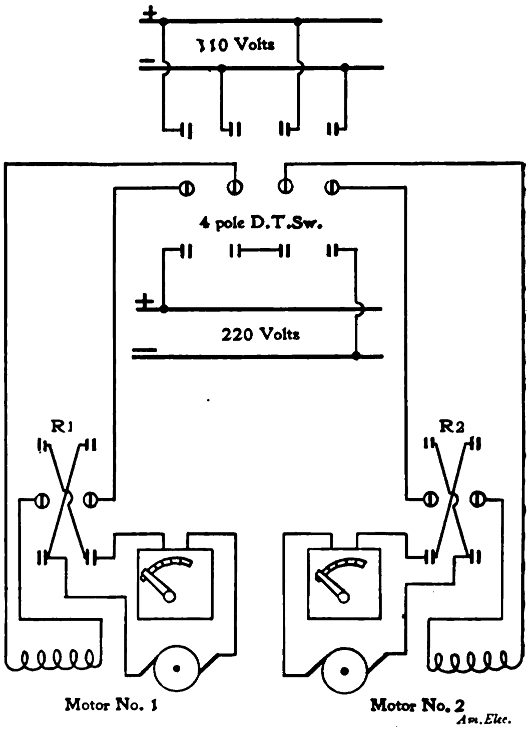


FIG. 1.—MR. BARTON'S SOLUTION.

To the Editor, American Electrician:

The accompanying diagram (Fig. 3) is one solution of Mr. Lincoln's problem in motor connections. Each motor armature is connected to an ordinary two-pole, double-throw, knife-blade switch for reversing; the free terminals of the field magnet windings are connected permanently together and to one post of a three-pole, double-throw switch, and the free posts of the reversing switches are connected to the other two posts of the triple-pole switch. Throwing the handle of the latter to the left puts the two motors in parallel on the 110-volt circuit; throwing it to the right puts them in series on the 220-volt circuit with the current reversed through motor *A*. This reversal does not affect the direction of rotation because both the field and armature are reversed in polarity. The motors should be fused individually, of course, to protect them when in parallel; the fuses would preferably be inserted in the two leads from the reversing switches to the main switch and in the two leads from the field magnet windings to the junction between them, but a three-pole fuse block might be used in the leads from the main switch posts by making the middle fuse equal to both the other two together. Each motor is provided with a starting box, *S*, which is put in the armature circuit in order to reduce the number of parts remaining "alive" when one or both of the reversing switches are open and the main switch closed. It is obvious that two motors of this type cannot be operated satisfactorily in series unless their loads are practically equal, but as nothing was said in the stated problem about this, I have not considered it in the submitted solution.

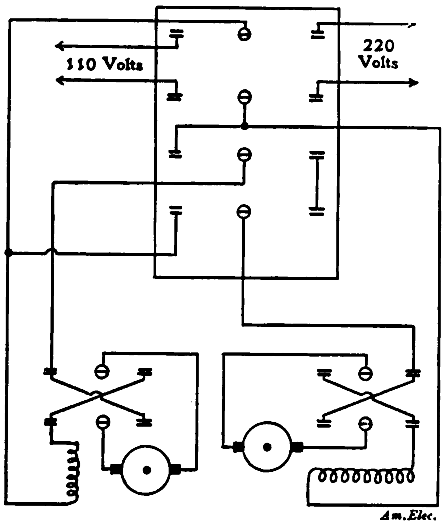


FIG. 2.—MR. CLARK'S SOLUTION.

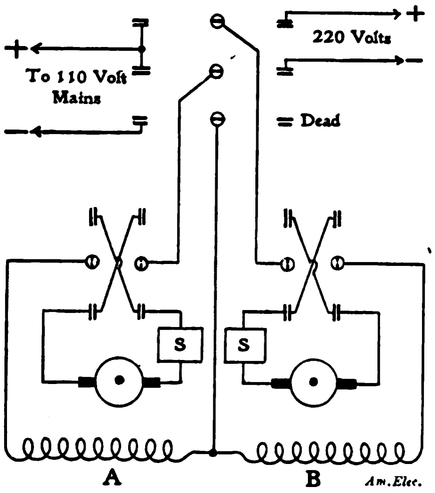


FIG. 3.—MR. MALCOLM'S SOLUTION.

GEORGE W. MALCOLM.

Brooklyn, N. Y.

[Richard Gessner, Oak Park, Ill., and Frank F. Redding, New York, sent in solutions like Fig. 3 except that the starting boxes were connected in the field circuits instead of the armature circuits; that is, in that part of the motor circuit between the reversing switch and the junction between the fields.

Charles B. Smeeth, Ironwood, Mich., sent in a diagram like Fig. 3 except that no starting boxes were included.—EDITOR.]

To the Editor, American Electrician:

I enclose herewith a solution of Mr. Lincoln's problem in motor connections (Fig. 4). The statement of the problem does not specify whether Mr. Lincoln already had reversing controllers for the motors or not, so I have assumed that they had only plain starting boxes. Two double-throw knife switches are therefore shown in the diagram for reversing the motors; the triple-pole, double-throw switch connects them properly to either of the supply circuits.

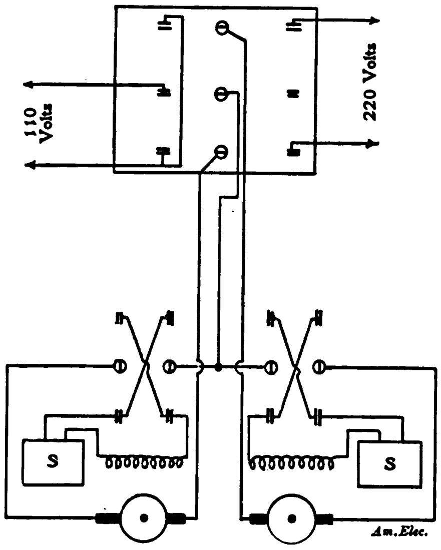


FIG. 5.—MR. SIEGEL'S SOLUTION.

As the system is simple, a detailed explanation is not necessary.

H. LEVAQUE.

Atlanta, Ga.

[Vernon R. Marshall, Chicago, Ill., sent in the same solution as Fig. 4, except that no starting boxes were shown.—EDITOR.]

To the Editor, American Electrician:

Enclosed you will find a solution of Mr. E. S. Lincoln's problem in motor connections. The diagram (Fig. 5) is practically self-explanatory; only three switches are used: one triple-pole and two double-pole, all of them double-throw.

C. R. SIEGEL.

Washington, D. C.

[W. H. Middleton, Jr., Princes Bay, N. Y., sent in a solution identical with this excepting that starting boxes were not shown.—EDITOR.]

To the Editor, American Electrician:

I send herewith a diagram (Fig. 6) as a solution of Mr. Lincoln's problem in motor connections. A four-pole, double-throw switch is used to connect the motors to either the 110-volt or the 220-volt circuit, and a double-pole, double-throw switch to reverse the two machines. A single starting box, *S B*, is used to start the two motors together; they must necessarily be thus started when in series on the 220-volt circuit, and if there is no objection to this arrangement there can be none to simultaneous starting on the 110-volt circuit. It is assumed, of course, that the motors will be properly protected by fuses; the arrangement of these is not a part of the problem, however, so I have not shown them in the diagram.

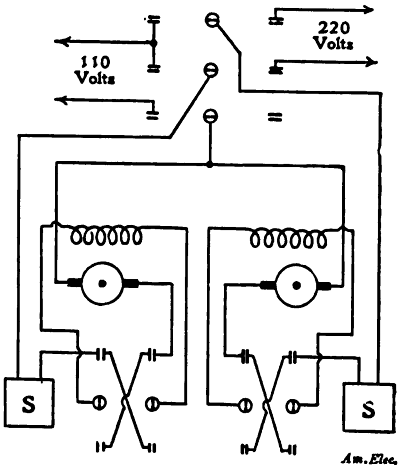


FIG. 4.—MR. LE VAQUE'S SOLUTION.

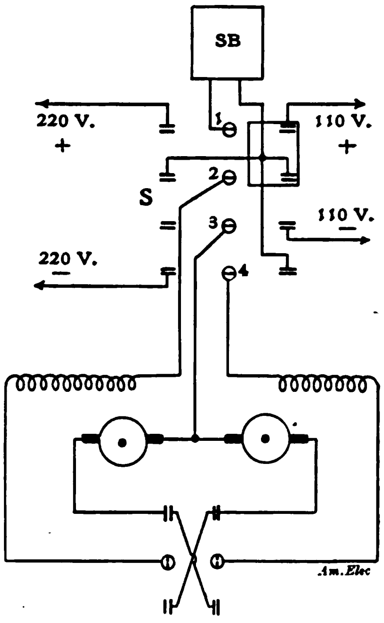


FIG. 6.—MR. MARSHALL'S SOLUTION.

JOHN J. MARSHALL.

San Francisco, Cal.

[The same solution was sent in by Jerome B. Wittkoski, Grand Rapids, Mich.—EDITOR.]

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

Which is regarded the standard primary voltage for central stations of moderate size and distribution area, 1000 to 1050 volts or 2000 to 2100 volts? N. B. U.

2000 to 2300 volts.

Where can I obtain castings for the voltmeter or ammeter described in the December, 1903, number of the AMERICAN ELECTRICIAN? D. S.

From Parsell & Weed, 129 West Thirty-first Street, New York.

Upon applying to the purification of beer a process for sterilizing water electrically, the fuses in the electrical circuit blow out frequently. What is the cause, and how can it be overcome? P. H.

The cause is too little resistance in the circuit; insert some resistance coils or else use heavier fuses.

Please explain the action of the Lincoln synchronizer. W. R.

This instrument, its principle and operation, were fully described in our November, 1901, number. Space limitations prevent its description in this department, and we do not reprint any matter in the other pages.

What is the outside diameter of a gear having 5 inches pitch diameter, 60 teeth and 12 pitch; also of a gear of half the pitch diameter and number of teeth, same pitch? H. M.

Outside diameter = pitch diameter + $\frac{2}{\text{pitch}}$; consequently the gears are 5.1666 ins. and 2.666 ins. outside diameter, respectively.

If a person should stand on wet ground and touch the blades of a knife-blade switch with a piece of metal held in the bare fingers, the switch being in a "live" 110-volt circuit absolutely free from grounds, would the person receive a shock? J. H. G.

No. There is no such thing as absolute insulation, however, so that such an experiment would not be safe with a circuit of high potential, such as 2000 volts alternating or 5000 volts direct current (arc light).

What is the advantage of grounding the secondary circuit of a transformer? A. C. L.

If the circuit is grounded on one side, the maximum difference of potential that can occur between the line and the ground is equal to the secondary voltage; if the transformers are grounded at the middle points of their secondary windings, the maximum possible potential difference between the secondary line and ground is one-half the secondary voltage. Crosses or leaks between the primary and secondary windings of the transformer, then, cannot cause dangerous potentials between the secondary line and ground.

What feature of engine construction or operation determines whether it is a high-pressure or a low-pressure engine? (2) What determines the identity of the high and low pressure cylinders of a compound engine? (3) Is a condensing engine necessarily a low-pressure engine? W. R. McD.

The pressure at which steam is delivered to the engine. The term is empirical; an engine taking steam at any pressure above 60 pounds is a high-pressure engine, whether the initial pressure be 90 pounds or 200. Low-pressure engines are not generally built now. (2) The pressure of the admitted steam; hence the cylinder taking steam first is the high-pressure cylinder. (3) No; but a low-presure engine is necessarily a condensing engine, because the exhaust pressure is not high enough to overcome the back pressure of the atmosphere.

What is a link motion on a steam engine? (2) Is there in regular operation an engine having electrically-operated valves? (3) Is there in regular operation an engine having an electrically-operated governor? (4) What is the usual speed variation between no load and full load for engines driving electric generators? T. K. D.

An arrangement of links and a motion transmission by means of which the engine valve may be operated by either of two eccentrics, one for the operation of the engine in one direction and the other for running in the opposite direction. Every American locomotive is fitted with such an arrangement. (2) Not to our knowledge. (3) Not to our knowledge; but there are many engines equipped with automatic governors which are adjusted by means of electrical mechanism to give the proper shaft speed. (4) From 1 per cent to 2 per cent, according to the buyer's requirements or the designer's judgment.

In Miller's "American Telephone Practice" the author says, referring to tests for line insulation resistance, that the insulation resistance per mile of circuit is equal to the total insulation resistance of the line *multiplied* by the length in miles; should it not read "divided" by the length? W. M. L.

No. The leakage paths through the insulation between the conductor and the supports are in parallel; consequently their joint resistance is equal to the individual resistances divided by the number of leakage paths, or the resistance of one path is equal to the joint resistance multiplied by the number of paths, assuming all the paths to have equal resistances, which is the only practical basis. The longer the line, the more leakage paths there will be, and consequently the lower will be the total insulation resistance. Mr. Miller's statement is therefore correct, on the assumption that the insulation is of the same quality everywhere along the line.

Please give a short formula for determining the resistance of a ground by means of a voltmeter. F. W. W.

No formula is generally applicable. The resistance of leakage paths between the conductors and frame of a dynamo may be determined by the formula

$$R_i = \left(\frac{E}{v} - 1\right) R,$$

in which E is the e.m.f. at the brushes of the machine, v is the indication of the voltmeter when connected to one brush and the frame, and R is the resistance of the voltmeter from terminal to terminal. The insulation resistance of an entire installation may be measured in the same way, E being the e.m.f. across the mains and v the lower of two voltmeter readings obtained with the instrument connected between a good solid "ground" and first one side and then the other of the circuit. The measurement of the resistance of an accidental "ground" on a circuit depends on local conditions.

Is it good practice to supply incandescent lamps and motors from the same circuit? (2) What system of wiring is best for incandescent lighting at 240 volts? (3) Is a No. 3 wire large enough to carry current 100 feet to two 25-h.p. 240-volt motors, allowing 3% drop in the line? (4) What is the best method of making connections between a travelling crane and the supply line? G. S. D.

It depends on local conditions. If the supply conductors are of sufficiently large cross-section to prevent objectionable fluctuation in voltage when the motors are thrown in and out of circuit, it is permissible to supply lamps from the same circuit. Generally speaking, it pays to run separate circuits rather than to use a common circuit with conductors large enough to avoid serious fluctuations. (2) There is no "best" system. Usually it is preferable to use the three-wire system, 120 volts on each side of the neutral, with a motor balancer to equalize the voltages. (3) Yes, so far as the drop alone is concerned, but it is not large enough to comply with the underwriters' requirements. If the wire be rubber covered, if must be No. 0000 single or two No. 1 wires in parallel in each leg; if weatherproof, it must be either No. 0 single or two No. 4 wires in parallel. (4) By means of strap conductors mounted parallel to the crane travel and collector shoes mounted on the crane and sliding along the straps.

Can shunt-wound dynamos be operated in parallel without an equalizer? (2) How can shunt-wound and compound-wound dynamos be operated in parallel? (3) What classes of work are series, shunt and compound-wound motors used for? (4) If a motor driving a machine requiring the full power of the motor at normal speed be reduced to half speed by a regulating rheostat in the armature circuit, will the motor be overloaded? (5) If a 220-volt motor be operated at 190 volts, will not the speed be reduced and the armature current increased, as compared with what it would do on 220 volts? T. N. S.

It would be impossible to use an equalizer with them; the equalizer between dynamos operating in parallel is for the purpose of equalizing the current in the series field windings. (2) As though the compound-wound machine were shunt-wound; if there be more than one compound machine, all of that type must have an equalizing connection between them. (3) Series-wound motors are used where full load or over must be started from standstill and the speed may vary inversely with the load; shunt machines are used where practically constant speed is required and the load at starting is relatively small. Compound-wound motors are used where heavy loads must be started from standstill and the speed must not vary widely under varying loads; if practically constant speed is required, the series windings are short-circuited when the motor has almost reached normal speed. (4) Not unless the torque required by the driven machine is greater at half speed than it is at full speed. (5) Yes, if the load is exactly the same; the difference will not be important if the motor is well designed, however.

NEW HAMILTON-CORLISS STEAM ENGINE.

The Hooven, Owens, Rentschler Co., Hamilton, Ohio, has added to its well-known line of Corliss engines a vertical cross-compound type, the 2500-h.p. size of which is illustrated herewith. This engine is to be exhibited at the St. Louis Exposition, in conjunction with a National Electric Company alternator, the revolving member of which will be mounted directly on the engine shaft between the crank housings, as shown in Fig. 1. The alternator was described in our issue of May, 1904.

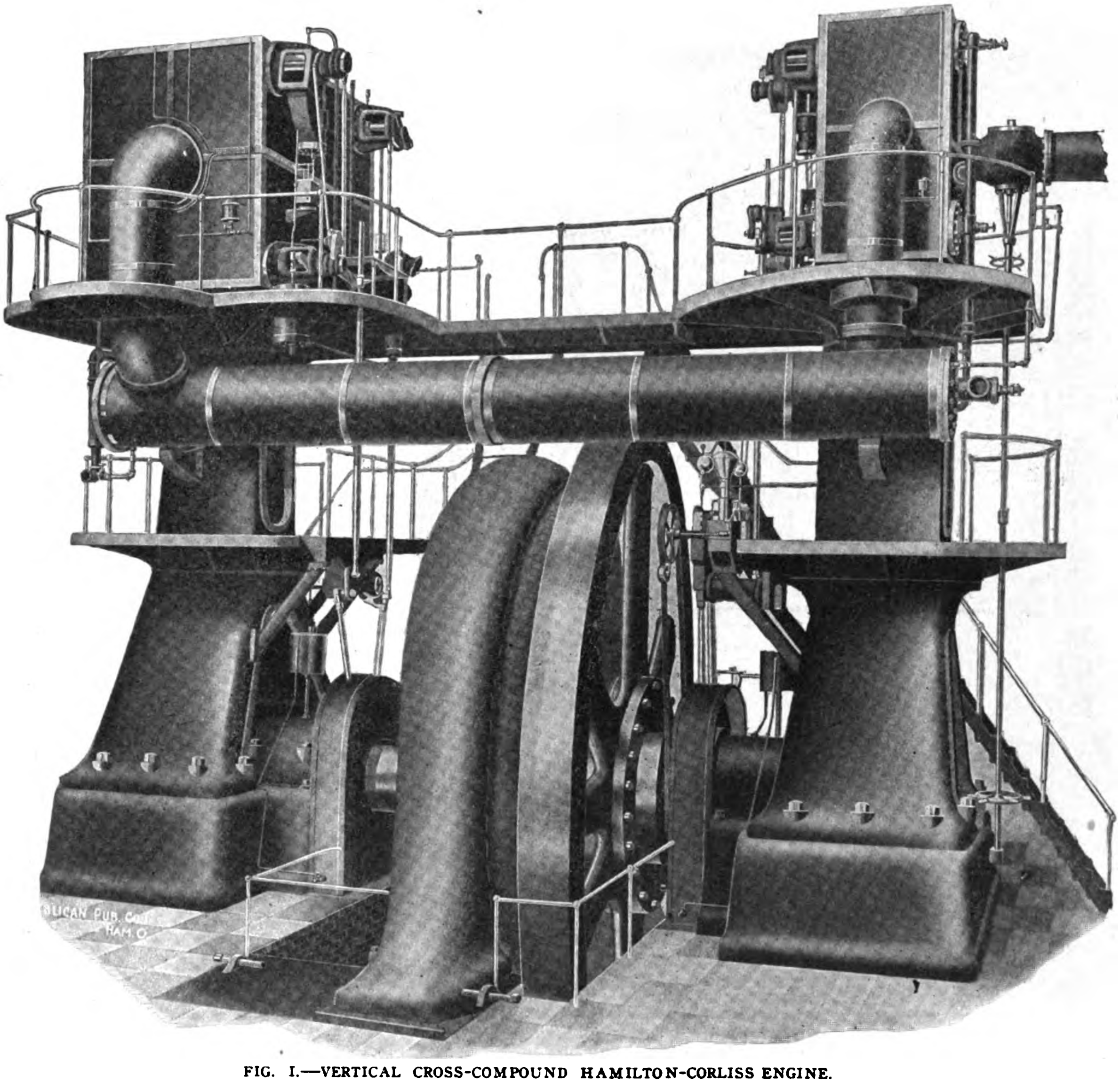

LICAN PUB. Co.
HAM. O.

FIG. I.—VERTICAL CROSS-COMPOUND HAMILTON-CORLISS ENGINE.

The bed-plate is of the box-section type, deep, massive and strongly webbed, with liberal bearing surface on the foundation. It is cast in one piece, and is carried around the crank at full height, forming a deep crank pit to retain oil. This base has easy lines and well-rounded corners. The main bearing portion is bored and faced to receive the bottom box, which is of the shell type, and so arranged that it can be removed by raising the shaft enough to remove the weight from the box. This box is arranged for water circulation.

The "A" frame is cast in two pieces, strongly webbed, and is planed and fitted together and bolted with reamed fitting turned steel bolts. Its lower portion is of the box, or rectangular section, which gradually changes to a circular section as it reaches the top, giving pleasing, but strong lines. The openings on the sides are especially designed to receive oil shields which entirely enclose this part of the engine. The guide barrel is circular in form, slightly flattened on the sides where the openings come, and the latter are designed for perfect fitting oil shields and doors. This portion of the frame is also strongly webbed. The guides are separated from the walls of the barrel by an air space, and are bored from a common center. The barrel is faced at both ends at the same setting, in order to obtain perfect alignment.

The cylinder sizes of the Exposition engine are: High-pressure cylinder, 34 ins. diameter; low-pressure cylinder, 68 ins. diameter; stroke, 54 ins.; speed, 83 r.p.m.; main bearings, 25 ins. diameter by 42 ins. long; shaft in wheel and generator, 30 ins. diameter; crank pin, 11 ins. diameter by 11 ins. long; wheel, 22 ft. diameter; weight, 120,000 lbs. The cylinders are made of close-grained charcoal iron, as hard as is practical to machine them. The exhaust chambers are separated from the cylinder walls by an air space. The arrangement is such that there is a 2-in. space between the cylinder walls and lagging for non-conducting covering. They are lagged with sheet steel with bright polished angle steel. The valves are located in the barrels to avoid the inconvenience of having to disconnect the valve gear when the heads are removed. The valves, however, have been placed in such a manner as to reduce the clearance to about the same as if they were placed in the heads by bringing the exhaust valves partly within the cylinder walls, although at no time do the valves enter the space swept by the piston, while the piston is allowed to sweep past the ports. The arrangement is different on the steam valve side. The ports on this side are so arranged that the incoming steam strikes the piston squarely on the end, thus preventing any side shock or pounding common to the vertical type of engine. Both steam and exhaust valves are double ported and have a very short travel. The valves are cored and made as light as possible.

The pistons are also cored and made as light as is consistent with the proper factor of safety. Each piston has a follower ring and one sectional ring, which is pressed out by spiral springs held in place by T-headed brass bolts. The pistons are forced on a taper and locked with a jam nut and keeper. The cross-head is of steel, with cast-iron slippers, lined with best phosphor babbitt, peined in, bored and scraped to fit. Each slipper has a wedge adjustment which is entirely independent, hence the position of the slipper is not changed by its movement. The slippers are fastened to the cross-head by several steel bolts, thus relieving the wedge bolts of any extra strain, and are so arranged that they can be easily removed. The piston rod is fastened to the cross-head by threads, jam nut and keeper. The connecting rod is of the solid end pattern, and is five and one-half cranks long, with wedge adjustment at either end, so arranged that in taking up the boxes the length of the rod and clearance spaces remains constant. The boxes are of bronze, babbitted, peined, bored and scraped to fit.

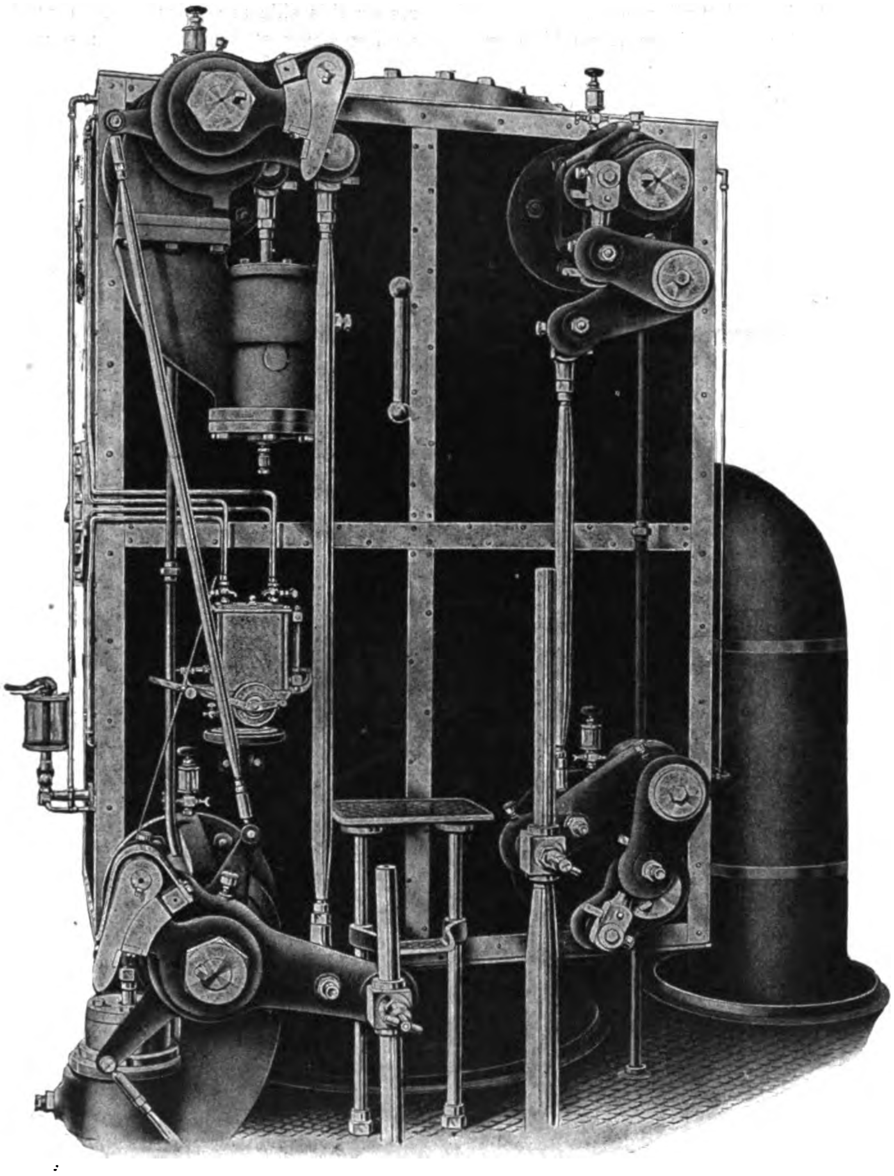


FIG. 2.—HIGH-PRESSURE VALVE GEAR.

The valve gear differs somewhat from the company's regular type. The steam and exhaust valves are actuated by separate eccentrics, direct, without wrist plates, as shown in Fig. 2 herewith. The necessary motion is obtained by the use of levers and links on each bonnet separately, thus greatly reducing the strains. The dash pots are hung from the bonnets and are close to the cylinder, making a very compact and self-contained arrangement. They are of the manufacturer's new noiseless pattern, with the weight of the moving parts greatly decreased, and are adapted for much higher speeds than usual. Both steam and exhaust cam rods have efficient unhooking devices, so that the valve gear can be worked by hand to facilitate starting and warming up. The valves are double ported, with very short travel, and, hence, have very little wear. The dash-pot levers are placed on the valve stems within the opening of the bonnet, and, therefore, are well supported on both sides to reduce wear. The releasing gear hooks and latch block trip plates have eight reversible wearing edges. All valve-gear connections are made to run as nearly noiseless as possible. The links have bronze connections with key adjustments. The governor is of the high-speed, center-weighted, fly-ball type, with motor and micrometer attachment for changing speed from switchboard to regulate for throwing in parallel. It is placed on the first gallery platform, and is easily accessible. Both cylinders are under control of the governor. The intermediate rocker arm supports for the eccentric rods are of box section, strongly bolted to the guide barrel, and are reinforced by braces from the "A" frame.

The fly-wheel is made in eight segments, a section of the rim and one arm to each segment. These segments are carefully planed and fitted at the joints, and are bolted to the hub with turned steel bolts, holes being reamed for a driving fit. The rim is clamped together with steel arrow-headed links, which are shrunk in place. The hub is in two separate discs forced upon the shaft. These discs are drilled and reamed and are bolted to the arms with turned steel bolts.

The main bearings are lubricated by a continuous stream of oil, furnished by an oil pump driven from the eccentric. The oil is pumped from a tank, located beneath the floor, to two receivers, which are located over each main bearing cap. From there it flows by gravity to all parts of the journal. The bottom box of these journals is cored out and arranged for water circulation. The eccentrics, cross-head slippers, cross-head and crank pins are oiled from a gravity feed system by multiple sight-feed tanks located on the upper part of the engine. The cross-head slippers have wipers on the bottom end, which dip into reservoirs at the bottom end of stroke, insuring perfect lubrication of the guides. All the valve gears, rocker arms, etc., are lubricated from grease cups. The engine is thoroughly furnished with oil guards and shields to prevent oil from being thrown on the floor. The eccentrics are entirely enclosed, to prevent oil from creeping along the shaft and reaching the generator.

These engines will be built in sizes ranging from 16 ins. and 32 ins. by 36 ins. stroke to 48 ins. and 96 ins. by 60 ins. stroke.

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THE MAGNETITE ARC LAMP.

During the past few years various means have been devised for improving the efficiency of the arc lamp, the improvements consisting for the most part in the addition of metallic salt to the carbon, which evaporating in the arc makes this luminous and hence increases the amount of light delivered by the lamp. The addition of such substances, however, entails many difficulties and also precludes the use of an air-tight globe owing to the dust which is produced when the lamp is burned. The General Electric Company has brought out an arc lamp in which magnetite, or the black oxide of iron, plays an important part. In this lamp the negative electrode consists of magnetite and is consumed. The positive terminal is not replaced, but is a copper segment and constitutes a permanent part of the lamp. The production of a non-consuming, positive electrode is made possible if this be given a sufficient heat conductivity which will not permit it to become too hot, but sufficiently so to avoid the deposition of material on it. With the magnetite are incorporated other substances, as arc-steadying compounds, titanium compounds for increasing the efficiency, etc. With the use of such an electrode rates of consumption of twenty to thirty hours per inch are produced, which gives a life of 150 to 200 hours for an 8-in. electrode. With very little sacrifice of efficiency, a life of 500 to 600 hours is produced, which, while obviously valuable in cases where trimming is difficult, is hardly needed for general illumination, since a street lamp should be looked after oftener than this. In the magnetite arc all the light comes from the arc flame and an arc length from ¾ to 1⅛ ins. is therefore most efficient. In order that a constant volume of light may be produced, the arc length should be constant, which calls for a feeding mechanism different from the floating system of the carbon arc lamp and which is obviously much simpler. The operation of the magnetite arc lamp is as follows: When the current is turned on the arc is struck by separating the electrodes to a definite distance, say ⅞ in. The electrodes are then locked in this position and remain fixed for some hours, when by the consumption of the negative electrode the arc length, and thereby the arc voltage, has increased sufficiently to operate the feeding mechanism which resets the arc to its original length.

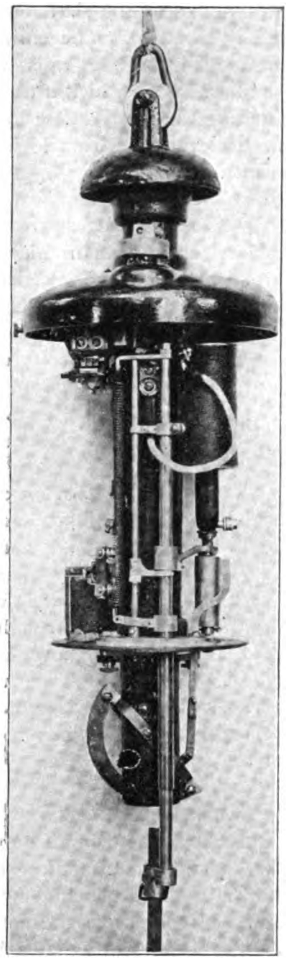
FIG. 1.—MAGNETITE ARC LAMP.

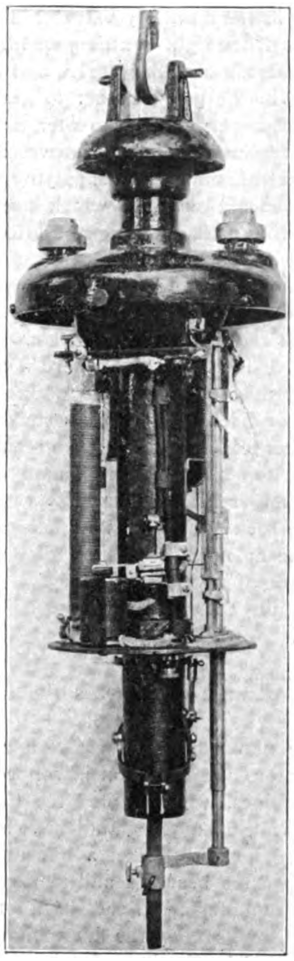
FIG. 2.—MAGNETITE ARC LAMP.

FIG. 3.—LUMINOUS MAGNETITE ARC.

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A HIGH-SPEED MOTOR-DRIVEN PUMP.

The operation of pumping machinery by electric motors offers, especially in mines, many obvious advantages. The electric-driven pumps, however, have had one drawback which, while not serious, had nevertheless to be taken into account. This was the necessity of toothed gearing, belts or other devices to transfer the power from the rapidly revolving motor shaft to the slow-moving crank-shaft of the pump. In the pump which we illustrate herewith these objectionable features have been eliminated by the simple expedient of connecting the pump plungers to cranks mounted directly upon the shaft of the motor. This pump has a capacity of about 250 gallons per minute against 1000 ft. head when running at a speed of about 300 revolutions. Its mechanical efficiency is claimed to be over 93 per cent, approximating closely that of the highest types of large steam pumping engines. The pump is of the duplex type, the cranks at the opposite ends of the motor shaft being set at right angles to each other. The plungers are of the outside-packed pattern and the two plungers of each pump are connected by side rods. The plungers are 3½ ins. in diameter and have a stroke of 5½ ins. The pump and motor are mounted upon a rigid box-girder frame and the unit is self-contained and occupies a relatively small space. It contains many novel features of construction, and careful attention has been given to the design of the internal parts, as well as to the running parts and oiling devices. This type of pump, which has only lately been introduced, has many advantages, including simplicity of construction, small space requirements, cheapness of installation and attendance. The pumps are built by the Blake & Knowles Steam Pump Works, New York, in capacities of from 200 to 4000 gallons per minute and for heads varying from 100 to 2000 feet.

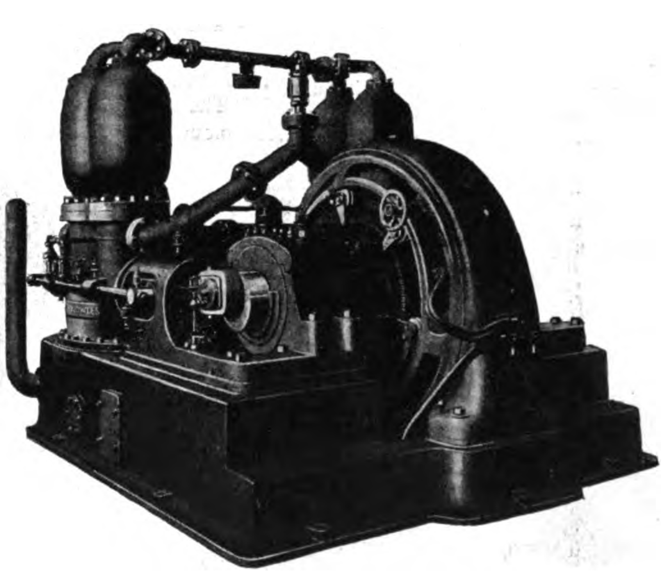


FIG. 1.—HIGH-SPEED MOTOR-DRIVEN PUMP.

New Apparatus and Appliances

ELECTRICIANS' TOOL CHESTS.

In an article under the above title which appeared in this colume last month, it was erroneously stated that the chests were manufactured by William Vanderman. While Mr. Vanderman is the inventor of these chests, the manufacturer is the Vanderman Plumbing and Heating Company, of Willimantic, Conn.

FIBERLITE SHADE AND HOLDER.

The Applied Device Company, of Springfield, Mass., has brought out the shade and holder shown by Fig. 1 herewith. The holder is made of heavy wire, all in one piece, and clamps the lamp socket with a catch similar to a guard. It fastens to the inside of the shade, and any tendency to pull it off only makes it hold more securely. The shade is made from a fibre similar to that used for the lining of sockets, and is colored mottled green on the outside and pearl gray inside. The fibre is finished under pressure, which gives it a glossy finish. It is tough and springy and is not easily crushed out of shape.

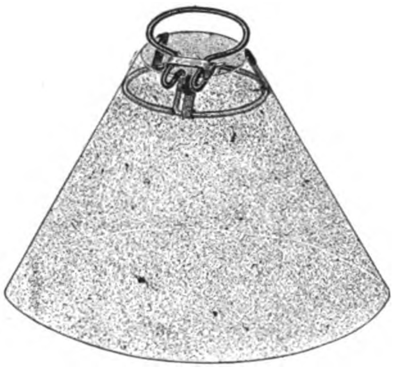


FIG. 1.—FIBERLITE SHADE AND HOLDER.

IMPROVED POP SAFETY VALVES.

The Crane Company of Chicago, Ill., has brought out a number of improved forms of pop valves for stationary, marine, locomotive and portable boilers, whose construction embodies a self-adjusting feature which automatically regulates the pop of the valve. The self-adjusting auxiliary valve and spring are entirely independent of the main valve and spring. The steam in the pop chamber finds a passage through holes or ports into an annular space provided in the auxiliary valve or disc, and by reason of the light auxiliary spring this pressure lifts the auxiliary valve and allows the steam in the pop chamber to gradually escape, thus permitting a greater range in setting pressures with the least waste of steam, and at the same time supplying a cushion or balancing medium which prevents any chattering or hammering and affording easy action in closing. The encased spring valves are constructed with a casing or chamber enclosing both springs and protecting them against the action of the steam. This form of valve is also useful where a number of valves may be connected to one main exhaust or discharge pipe. The encasing spring chamber extending over a greater portion of the top surface of the main valve, prevents any retarding action from the steam due to back pressure, which might be caused by one or more valves opening slightly in advance of another, in having any material effect on the free opening of the main valve.

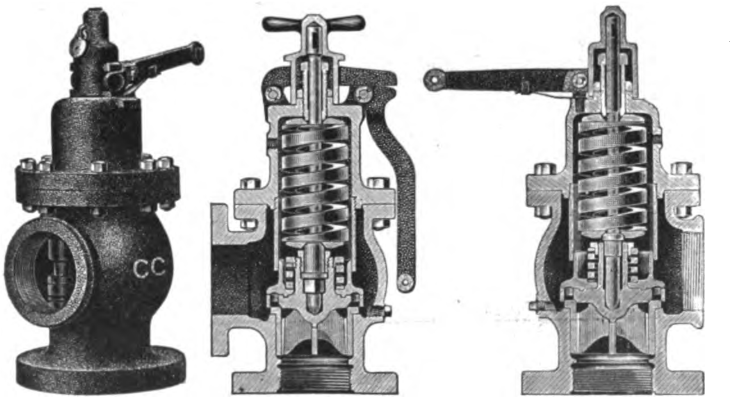


FIG. 2.—POP SAFETY VALVES.

THREE-BEARING GENERATORS FOR GAS-ENGINE PLANTS.

The numerous calls for a line of small generators for operation in connection with gas engines, has prompted the Commercial Electric Company, of Indianapolis, Ind., to prepare for the market a line of machines having three bearings and a heavy balance wheel mounted upon the shaft for the purpose of overcoming the fluctuations in speed occasioned by the irregular impulses of the gas engine. This construction makes it possible to secure good lights with almost any practical gas engine; makes unnecessary the awkward counter shaft previously used in belt dynamo installations, and subjects the dynamo shaft to no damaging strain as is the case where the heavy balance wheels is used on any two-bearing dynamo. The generator construction throughout is that of their standard yoke type with the exception of the bearings. The armature is carried by three pedestals mounted upon a cast iron base each of which contains a bronze-lined self-oiling bearing. The paper pulley is mounted direct upon the hub of the balance wheel and the combined "paper pulley" is supported closely, on both sides, between two of these pedestals. This arrangement, together with an extra heavy shaft, makes impossible any strain from the weight of the balance wheel or the pull of the belt, upon the portion of the shaft on which the armature is mounted. The entire machine is carried upon sliding rails with hand wheels and screws by which it can be shifted for tightening the belt. These dynamos are made in sizes ranging from ½ kilowatts to 30 kilowatts.

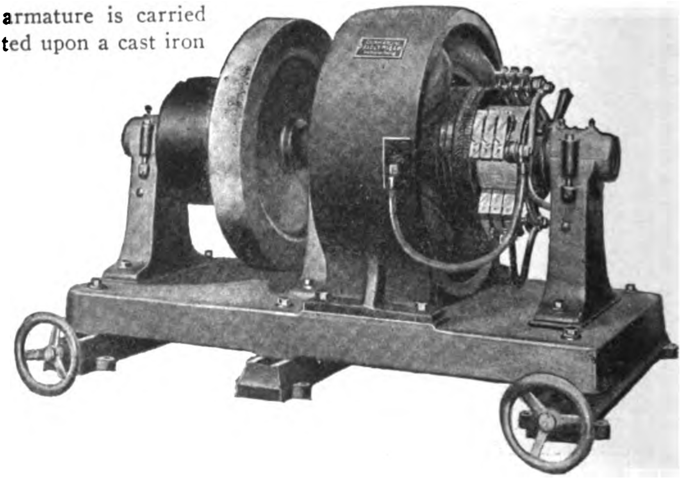


FIG. 3.—THREE-BEARING GENERATOR.

500-VOLT CIRCUIT SWITCH.

The Hart & Hegeman Manufacturing Company, of Hartford, Conn., has brought out the switch shown in Fig. 4 herewith, which has been designed to operate safely and successfully on a 500-volt circuit with 20 amperes, and which, it is claimed, will break a current of 75 amperes at 500 volts. This is accomplished by passing the switchplate through a narrow slot between two porcelain barriers. The air space is so small that the manufacturer claims it is impossible for the spark to follow.

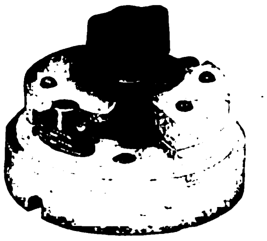


FIG. 4.

AUTOMATIC OIL FILTER.

The Burt Manufacturing Company, Akron, Ohio, is the manufacturer of the oil filter shown in the accompanying sectional view, designed to receive the condensation from oil separators and exhaust heads and to automatically separate the oil from the water, while at the same time purifying it. The water is drained to the sewer and the oil, rising into a separate chamber, overflows into the oil reservoir. The filter is made in twelve different sizes, with filtering capacities of from 300 to 500 gallons per 24 hours. The mixed oil and water is received through the inlet at the top of the filter and then passes through a layer of waste, which collects all the heavier impurities of the oil. Then it passes through the perforations in the bottom of chamber *B*, following the course indicated by the arrows, into tube *C*, and from here on to the filter plate *D*. The increased weight of the water has a tendency to keep the oil back in tube *C*, but when the pressure of the oil in chamber *B* becomes sufficient the oil is forced down and spreads over the plate *D* in a very thin film. This, it is claimed, constantly changes surface and grows thinner as it travels from the center to the circumference of plate *D*, thus exposing every particle of oil to the action of the water. It then flows on to plate *1D* and *2D*, going through the same process in each case. When the oil leaves the plate at *2D* it is said to be in a finely divided state and thoroughly washed by the water. It is separated from the water by gravity, and all the remaining impurities settle in chamber *E*, from which they can be drained to the sewer by opening the gate valve at the bottom of the filter. From the plate *2D* the oil rises and again filters through *F*, another layer of waste, into the pure oil chamber, where it accumulates until it overflows into the oil reservoir. The water is automatically separated after it passes down the tube *C* and reaches the bottom plate, on account of its being heavier than the oil, and the surplus water passes into the pipe leading to the automatic water-separating device.

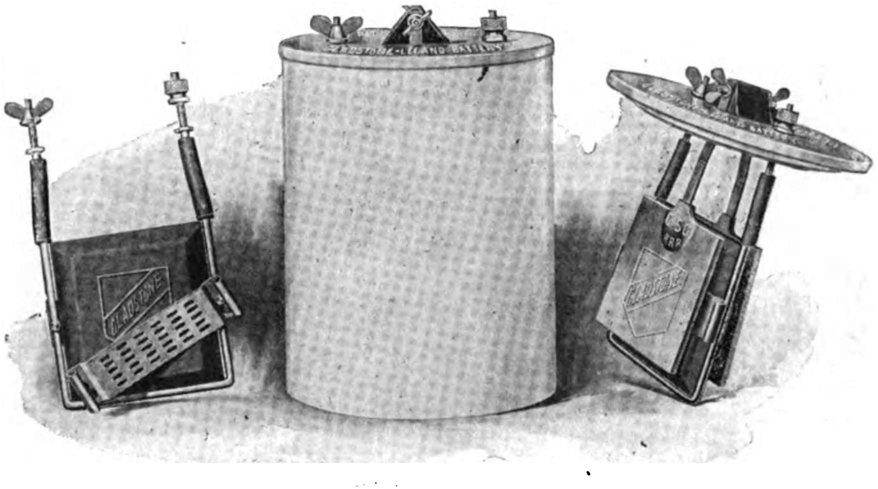


FIG. 6.—GLADSTONE-LALANDE PRIMARY BATTERY.

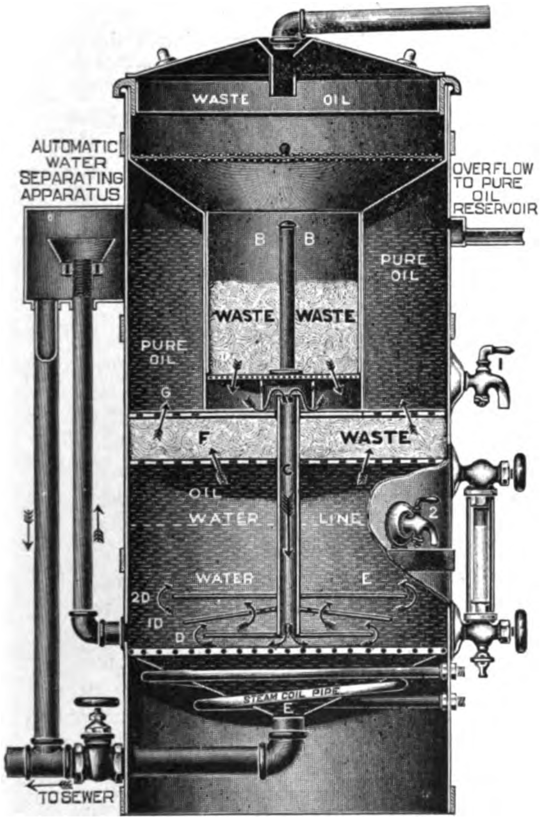


FIG. 5.—AUTOMATIC OIL FILTER.

THE GLADSTONE-LALANDE PRIMARY BATTERY.

The battery shown in the accompanying illustration is an improvement on the type of battery invented by De Lalande & Chaperon, of which there are several modifications on the market at the present time. In the Gladstone-Lalande battery the negative electrode is composed of a plate of agglomerated oxide of copper, having its surfaces reduced to the metallic state. This copper oxide plate is carried in a supporting hanger, made of copper rod formed into a U-shaped frame, the two free ends of which are threaded to receive clamping nuts, by which it is fastened to the porcelain cover of the battery. This supporting hanger is provided with two perforated, flat spring, copper clamps, attached to the opposite sides of the hanger. One of these spring clamps is riveted at each end to the hanger, and the other is detachable, having slotted eyelet holes at each end which fit over the two rivet heads on the sides of the hanger; the clamp is locked in position by being pulled slightly in a downward direction. The copper oxide plate is so placed in the hanger that one of its flat surfaces bears against the fixed spring clamp. The detachable spring clamp is then locked to the hanger, so that it bears against the other flat surface of the oxide plate, which is held firmly between the two spring clamps. The advantages possessed by this form of construction are that when the battery needs to be recharged the exhausted oxide of copper plate can be removed from the hanger and a new one substituted with the least possible loss of time, and without soiling the fingers. The wide surfaces of contact presented by the perforated spring clamps render it unnecessary for any cleaning or sandpapering of these parts when recharging the battery. The positive electrode consists in all cases of two flat plates, composed of an alloy of zinc and mercury, which are suspended from the cover. In some models these flat zinc plates are cast on an inverted U-shaped hanger, having a threaded extension which passes through a hole in the cover, to which it is clamped by a suitable nut. In other models (as shown in the illustration) the two zinc plates are cast on separate stems, having a hole at the upper extremity which allows them to be bolted to the projecting knob on the top of the cover, which is provided with a horizontal hole to receive a threaded bolt for this purpose. The electrolyte in all cases is a 20 per cent solution of pure caustic soda, and a layer of pure mineral oil is poured on top of the solution to prevent evaporation and creeping. These batteries are manufactured by the Battery Supplies Company, Newark, N. J.

AN AUTOMATIC LAMP SHADE.

The accompanying illustration shows an automatic lamp shade which the General Incandescent Arc Light Company, of New York, has placed on the market. The shade and holder can be instantly put on or removed from any size of electric light from four to twenty-four candle-power without removing the lamp from its socket, adjusting itself to the lamp automatically. In addition to the economy in time with the use of this shade, the manufacturer claims that it will double the amount of illumination thrown down by the lamp. The shade may be used on an upright portable lamp by bending the arms up to right angles and adjusting from inside the holder.

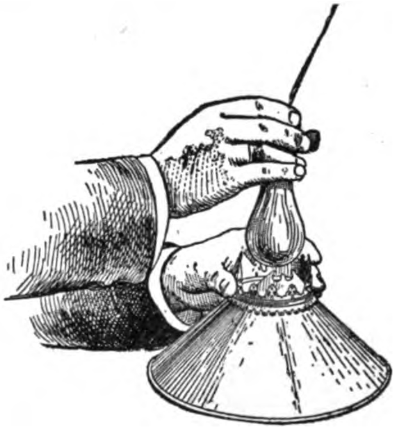


FIG. 7.—AUTOMATIC LAMP SHADE.

BOSS WEATHER-PROOF ENTRANCE BUSHING.

Fig. 8 herewith shows a weather-proof entrance bushing made by the Belcher & Loomis Hardware Company, of Providence, R. I., which has the approval of the underwriters. The cap is detached by simply

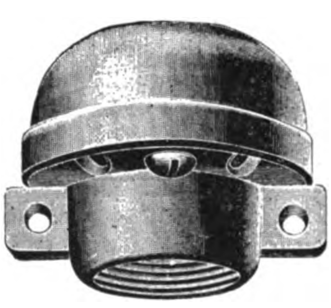


FIG. 8.—ENTRANCE BUSHING.

loosening the screw, and no fishing is required where the wires enter. The bushing prohibits any moisture getting in where wires enter the pipe, and one of the principal uses to which it may be put is in connection with a transformer where the house wires enter the conducting pipe. It makes a permanent and serviceable fitting and is easily installed.

CRESCENT RECEPTACLES FOR ELECTRIC LIGHT WORK.

The receptacle shown by Fig. 9 herewith is made by the Crescent Electrical Manufacturing Company, of Rochester, N. Y., from extra heavy porcelain, and has no exposed metal parts. Its use makes possible the easy reversal of wires from either back or front connections, and does away with the need of carrying a number of different styles in stock. The illustration is half the actual size of the complete receptacle.

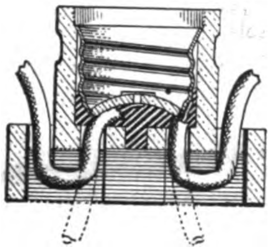


FIG. 9.—CRESCENT RECEPTACLE.

SOCKET PLUG FOR FLASHING LAMPS.

The Phelps Co., of Detroit, Mich., is introducing a socket plug for flashing incandescent electric lights on and off at the rate of about fifteen times a minute. This plug fits any Edison-type socket and holds any ordinary incandescent lamp. Each plug is complete in itself. Inside of an ordinary Edison base, there is a mechanism which makes and breaks contacts at intervals. This mechanism is operated solely by the lamp itself. As the lamp burns it generates a certain amount of heat in the socket, which causes a small thermostat to expand, thus breaking the contact, and when the lamp has cooled sufficiently the light is again automatically switched on. This is continued throughout the life of the plug, which is said to outlast several lamps. The contacts are of heavy platinum. The plug is known as the "Skedoodle" socket plug and can be used on either alternating or direct-current circuits.

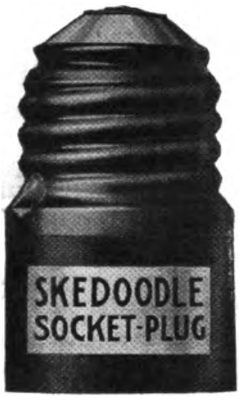


FIG. 10.

NEW SCREW-CUTTING BENCH LATHE.

The Seneca Falls Manufacturing Company of Seneca Falls, N. Y., has brought out the screw-cutting bench lathe shown by Fig. 11 herewith. The head stock has a large hollow spindle, made from a crucible steel forging, with draw-in chuck for split collets up to ½ in. capacity, and phosphor-bronze boxes with improved end-thrust ball bearings. The cone pulley has three steps for wide belt and with strong back gears gives six changes of speed. A push pin on the head gear allows the cone to be instantly locked or unlocked without using a wrench. The tail stock is of the curved or cut-under pattern, which allows the compound rest to swing around parallel with the ways and over the base of the tail stock, with room to operate the feed-screw handle. The spindle has an improved locking device, and the tail stock is provided with side adjusting screws for turning tapers. There is a long bearing on the bed and it is locked in such a manner as to render it firm and rigid. The carriage has a long bearing on the ways and is gibbed to the bed both front and rear. A cam-locking device locks the carriage to the bed when using the cross feed. The cross-feed screw has a graduated collar which reads in thousandths of an inch and can be set at zero in any position. Plain and compound rests are regularly furnished and easily interchanged. The base is graduated and renders the compound rest capable of fine adjustment. The automatic cross and longitudinal feeds are actuated by a phosphor-bronze worm on the lead screw, receiving its power from the head spindle through spur gears. The lead screw is splined and simply acts as a feed rod, hence the only wear on the threads is in screw-cutting. The automatic feeds are almost indispensable for a large variety of work, as they secure more accurate and smoother surfaces. The range of feeds is very large. The range for screw-cutting is extra large, cutting all standard threads, right or left (including 11½ in. and 27 in.), from 3 to 64 without compounding the gears and nearly all threads by compounding. Patented spring nuts are used in connection with split washers to hold the change gears in place. They are easy and convenient to operate and allow quick shifts of the change gears. The bed is 46 in. long, broad, deep, thoroughly well braced and accurately proportioned throughout. The rated swing is 9 ins, but it has an actual swing of 10 1-3 ins. over bed and 24 ins. between centers.

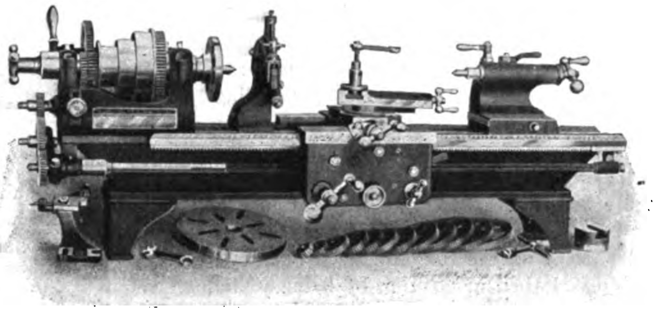


FIG. 11.—SCREW-CUTTING BENCH LATHE.

NEW BOOKS.

Wireless Telegraphy. By William Maver, Jr. New York: Maver Publishing Company. Cloth; 212 pages, 6 x 9 ins.; 121 illustrations. Price, $2.

Anyone who is familiar with Mr. Maver's "American Telegraphy" would naturally expect the present work to be of the highest merit; perusal of the book confirms the expectation. The author has dealt with the more complex subject of electrical wave telegraphy in the same simple, clean-cut style that characterizes his former work, and without any sacrifice whatever of either accuracy or clearness of exposition. There are a very few slips in diction and one or two bits of slightly careless technical description, such as "the lines of force of the primary wire" (of an induction coil), page 7, and "an oscillating current disrupts this bridge and thereby renders the electrolyte non-conducting," page 112. The lines of force are set up by the current in the primary wire, and it is the bridge, not the electrolyte, that was conductive before it was disrupted. These, however, are of infinitesimal importance compared with the general merit of the book.

The author gives an outline of the early work done by Preece, Phelps and others in other classes of space telegraphy, and explains fully, but not verbosely, the fundamental principles of Hertzian wave telegraphy, the variations due to the several workers in the field, and the practical operation of the several systems. He also describes very thoroughly the detail devices used or experimented with by Marconi, De Forest, Fessenden and others. The use of mathematics is limited to a few very simple algebraic formulas, almost all of the exposition being made in plain English. The book is cordially commended to all who are interested in its subject.

Ready Reference Tables. By Carl Hering. New York: John Wiley & Sons. Soft leather; 212 pages, 4 x 7 ins. Price, $2.50.

This is a book of conversion tables, or lists, rather, which include every unit of weight, length, surface, volume, pressure, work, energy, power, heat, temperature and money that has ever been put on record in any civilized country, together with all of the electromagnetic, electrostatic, photometric and physical units. Its scope, therefore, is enormous, and if the material were arranged appropriately the book would be correspondingly valuable. Unfortunately, the author considers, according to the preface, that the usual class of "tables of weights and measures . . . is quite unsuited for ready reference," and prefers to limit himself to lists giving merely the equivalents of each unit. These, of course, are extremely useful, but there is no comparison between them and the more familiar tables which save most of the labor of multiplication in reducing a given value in one system of units to the equivalent value in another system. The short expository text preceding each section of the work is highly useful and well written. Another commendable feature is the provision of a list of symbols and abbreviations at the front of the book with numbers showing on what page or pages each symbol or abbreviation is used; this is particularly advantageous where one symbol is used in two or more senses, which is, of course, unavoidable in a book of this scope. The choice of symbols is not always consistent, however; on pages 22 and 115, for example, *Q q* represent coulombs, while on page 116 *C c* are used; again, *B. T. U.* represents both Board of Trade unit and British Thermal unit unnecessarily, since it is a simple matter to distinguish by using *B. Th. U.* or *B. t. u.* to represent the heat unit. The material in the book is jammed together in the most reckless disregard for the eyes or convenience of the reader, in many cases making the aid of a ruler necessary in order to trace along a line without losing the line. The price asked for the book removes the only possible excuse that might have been offered for this unseeming crowding, as well as for the extremely economical use of conversion tables proper.

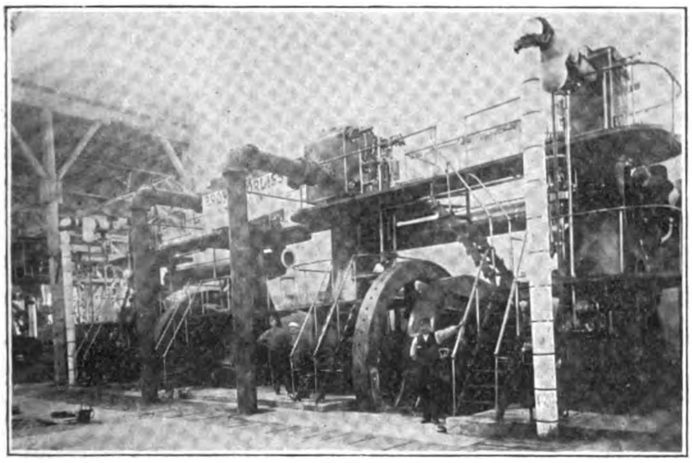
SOME EXHIBITS AT THE ST. LOUIS EXPOSITION.

Although the exhibits of the electrical and allied industries at the Louisiana Purchase Exposition are not fully completed at this writing, enough are installed to impress one with the vast and diversified character of the exhibits generally, not to speak of the stupendous amount of labor involved in their selection and arrangement. So numerous are the points of interest, and so prominently are they brought out, that we regret space limitations permit only a passing mention of some of the most important of those which naturally fall within the scope of this journal.

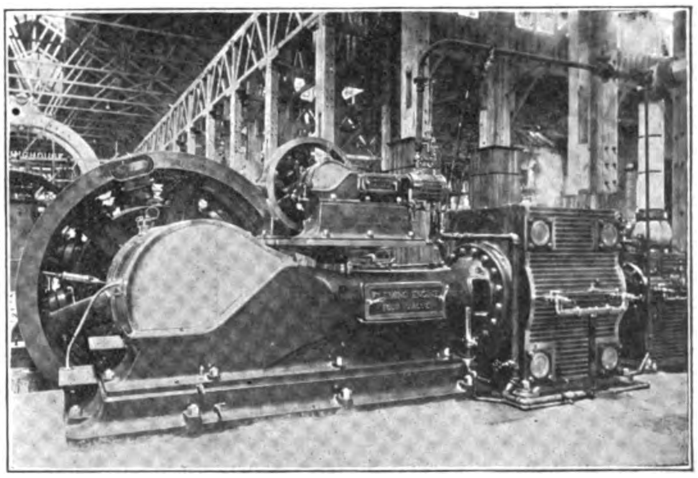
The booth of THE AMERICAN ELECTRICIAN is arranged for the comfortable reception of visitors. Complete files of the various technical journals and a library of electrical books published by the McGraw Publishing Company are placed at the disposal of visiting engineers. A complete record of all those interested in electrical industries who go to the Exposition is kept in a register provided for that purpose. Those who desire to write and those who desire to correspond will find ample facilities for so doing. The booth is below the office gallery of the Electrical Department, and a view is given in the accompanying illustration.

McGraw Publishing Co
AMERICAN ELECTRICIAN
The ENGINEERING RECORD
ELECTRICAL WORLD AND ENGINEER
STREET RAILWAY JOURNAL

M'GRAW PUBLISHING COMPANY'S BOOTH.



BROWN-CORLISS ENGINE COMPANY'S EXHIBIT.



HARRISBURG FOUNDRY AND MACHINE WORKS' EXHIBIT.

BROWN-CORLISS ENGINE COMPANY, Corliss, Wis., has two engines in the exhibitors' power plant, which drive 500-kw. railway generators for the Intramural railway. These are vertical cross-compound condensing engines having a rated horse-power capacity of 750 with 150 pounds steam pressure. The cylinders are made double ported and the ports are made large enough so that the piston heads partially cover the pockets at the end of the stroke. The movement of the valve-gear and dash-pot is very small. All these things tend to make possible quick action of valve-gears and quick opening of steam ports.

HARRISBURG FOUNDRY AND MACHINE WORKS, Harrisburg, Pa., have a 600-h.p., four-valve, Fleming engine on exhibition in Machinery Building. This engines operates at a speed of 150 r.p.m., and is remarkable for the smoothness of its operation. It is direct connected to one of the Crocker-Wheeler generators which furnishes current for the Intramural railway. The engine has cylinders 15 ins. and 40½ ins., with a 26-in. stroke. The governor is located on the shaft and acts on one of the eccentrics. There are three eccentrics on the engine, one of which is controlled by the governor and therefore controls the point of cut-off of the high-pressure cylinder. The second eccentric is fixed on the shaft and controls the inlet valves of the low-pressure cylinder, each having its point of cut-off fixed. The third eccentric opens and closes the exhaust ports, four of which are provided in each cylinder. Automatic lubrication is employed. The crank chamber is closed and partly filled with oil and the crank-pin and guide rods are lubricated by the splash of oil in the crank chamber. Near the top of the crank chamber, above the lever and the main bearing, is a trough which receives some of the oil splash and delivers it by gravity to the main bearing.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, attractively displays its telephone apparatus. This includes two complete working automatic exchanges of the 10,000 type, each with 100 stations installed. These exchanges, which are now giving service throughout Electricity Palace, are connected together by a system of trunks similar to those used in connecting branch exchanges. The selection of trunks is, however, performed automatically. The telephones exhibited are of three types—wall, desk and pedestal. All are fitted with the regulation calling dial for conveying electrical impulses to the switches at the central office. A toll board of ten stations is also in service, demonstrating the manner in which toll connections are given to users of automatic telephones. The remainder of the apparatus is of the same general character as that used in any modern telephone exchange, save the "tell-tale" board. This is a device for the instantaneous location of trouble and consists of a number of lamps and a magneto bell. In case of trouble, this magneto bell by its ringing arrests the attention of the attendant and a lamp glows, by the position of which on the board the location of the trouble can be instantaneously ascertained.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., has an interesting exhibit characterized by light and motion. There are sixty arc lamps in and around the space, giving a most brilliant illumination. A ten-panel switchboard is provided for distribution and regulation. Two supplies of current are received from the building sub-station, one a three-wire, 220-volt, direct-current, and the other a 500-volt, direct-current. A series of motor-generators convert this current for the different applications. Transformers ranging in capacity from 1 to 500 kilowatts are displayed, as well as windings and sections which illustrate the methods of insulation. The different types of wattmeters made by the company are shown under operating conditions on the switchboard panels, and all the principal parts used in the construction of these instruments are mounted in cases. At the corner of the two aisles a standard carries a number of Fort Wayne oscillating fan motors. Not the least interesting item in the space is an arc light machine constructed by Mr. J. J. Wood in May, 1879.

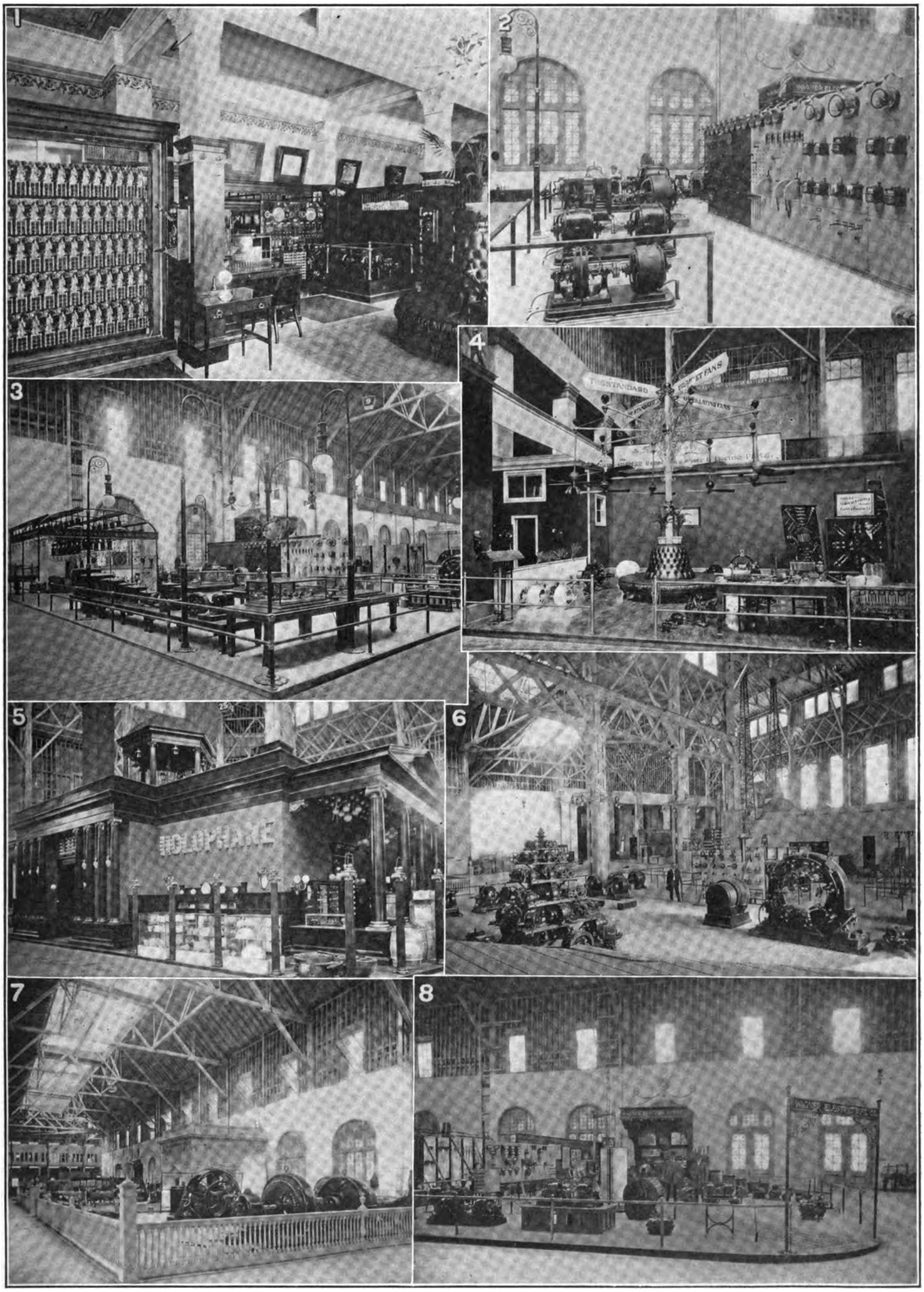
THE ROBBINS & MYERS CO., Springfield, Ohio, displays its "Standard" motors and dynamos. These machines are shown in sizes ranging from 1-30 horse-power to 15 horse-power; these sizes include all the machines built by the company. One of the machines is dismantled in order to show its construction, insulation and interchangeable parts. An immense revolving fan motor rack forms a unique feature of the exhibit. From the extremities of each of the six arms of the rack is suspended a ceiling fan motor and above each arm is a desk fan motor with the plane of the fan nearly parallel with the arm. The twelve fans are all revolving, the desk fans causing the entire rack to rotate, thus keeping the air in that section in circulation. Another interesting exhibit item is a magnetic separator, used for extracting particles of metal from the cotton before it reaches the gin.

HOLOPHANE GLASS COMPANY, New York, has a most striking exhibit; 1000 electric incandescent lamps being used for illumination. The booth is in the form of a Grecian temple, fronting on three aisles in Section 25. Over the central doorway electric lights covered with Holophane globes form the word "Lux" in white letters, and on each side is suspended a large Holophane 16-in. ball hanging by three chains. On the door casing are torch brackets surmounted by pillars topped with Holophane globes containing three colored lamps. These are suitably connected to a Reynolds flasher, so that a change of color occurs at different intervals. Between these pillars are plate-glass cases containing samples of the different kinds of prismatic globes and reflectors manufactured by the company. The entrances over the side aisles are Grecian porches, the ceilings of which are studded with electric lights of different colors. The center room of the interior is divided into two portions, showing two dining-rooms identically fitted so far as fixtures and furnishings are concerned, but in one Holophane globes are used and in the other the ordinary globes, effectively illustrating the difference in the distribution of light occasioned by the use of the prismatic globes. On each side of this room there is another apartment suitably divided to show twelve dark rooms for comparing the different forms of Holophane globes and Pagoda reflectors with other kinds of globes and reflectors. The ceilings and walls are all of paneled oak, and in the center of the main room is an expensive fireplace.

WESTERN ELECTRIC COMPANY, Chicago, occupies a space fronting on two main aisles. In the center is a motor-generator equipment, consisting of two 100-kw. frames, the motor side taking current at 500 volts and the generator side delivering current at 220 volts. This unit operates in conjunction with a 15-kw. compensator, permitting the use of 110-volt current. The center space also contains two switchboards, one for controlling the operation of the apparatus receiving current from the motor-generator, and having all the necessary switches, circuit-breakers, ammeters, etc. The other board is for display purposes only, and on it are circuit-breakers, knife switches, voltmeter switches and kindred apparatus. In the extreme northeast corner of the space a small machine shop is installed, showing the actual operation of modern machine tools driven by Western Electric motors on the three-wire, multi-voltage system. In the northwest corner is a line of power motors arranged in the form of a pyramid, the smallest ones at the top. In the southwest corner is a series alternating arc light equipment, consisting of a full line of transformers, regulators and switchboards. Opposite this are ornamental arc lamp stands from which are suspended various types of arc lamps. There are also a number of sewing machine motors in operation. Fan motors and ceiling fans are distributed throughout the space, suspended from overhead, and a number of boards containing supplies manufactured by the leading companies throughout the country.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, exhibits its new street railway motors. Railway motors of 550 horse-power are shown in its space in Electricity Palace, one of which is open. Others are to be mounted on trucks and shown in operation in connection with a railway controller. The motors are arranged for lubrication by means of pads mounted on springs and bearing against the journals and are built to open from below. Ventilation is provided through the field cores, which are of laminated iron. In the pole tips, every other sheet of steel has been omitted, thus reducing by one-half the amount of iron in the tip. A prominent feature of the company's exhibit is a 500-kw., 25-cycle, rotary converter intended for railway use. This supplies current for the operation of the street railway motors in the exhibit. In connection with this converter are three 150-kw. transformers which step down the supply from 6600 volts to that required by the rotary. A motor-generator set with a synchronous, 60-cycle, three-phase motor and a direct-current generator with a capacity of 40 amperes at 550 volts is also included in the railway portion of the company's large exhibit. A large three-phase alternator partly assembled is exhibited for the purpose of illustrating the method of coil construction and insulation as well as the arrangement of the coils. A 250-kw. transformer water and oil cooler for high-tension voltage of 20,000 and a low-tension voltage of 2300 is shown. The company has equipped its space with a testing table and instruments to show to interested visitors the performance of the working apparatus in its exhibit. A large amount of space is given to the display of Bullock motors driving machine tools. The company occupies a space of 104 ft. x 54 ft. in Electricity Palace and has provision for the entertainment of visitors. One of the most prominent features in the Palace of Machinery is the 3500-kw., three-phase, 25-cycle, 6600-volt Bullock generator driven by an Allis-Chalmers combined vertical and horizontal compound engine. While available for any kind of service, this unit has frequently been used to carry the decorative lighting load, the gradual evolution from darkness to full brilliancy being accomplished by manipulating the field excitation.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has an exhibit whose purpose is to demonstrate the applicability of the single-phase motor for general power uses. The single-phase motor is shown driving machine tools, organ blowers, dough machines and ventilating fans. The speed of the machines is varied, giving changes from 8 to 1 by means of the controller. There are also on exhibition motor-generator sets, a direct-current generator being driven by a single-phase motor. The application of this motor to house pumps is demonstrated by its different equipments. The action of the motor is controlled automatically by the height of the water in the tank. This opens



A GROUP OF INTERESTING EXHIBITS.

(1) Automatic Electric Company. (2) and (3) Ft. Wayne Electric Works. (4) The Robbins & Myers Company. (5) Holophane Glass Company. (6) Western Electric Company. (7) Bullock Electric Manufacturing Company. (8) Wagner Electric Manufacturing Company.

or closes the switch, the cutting out of the starting device being controlled by the motor itself. The company also displays a full line of its well-known transformers of the air-cooled, self-cooled and water-cooled types. A five-panel switchboard is equipped with its high-tension switches and instruments.

National Electric Light Association Convention Notes

LORD ELECTRIC COMPANY, Boston, sent F. W. Lord to the Convention.

SIMPLEX ELECTRICAL COMPANY, Boston, sent Miss J. H. Mason to the Convention.

BAKER & CO., INC., Newark, N. J., had its interests well cared for by Mr. J. J. Lowthian.

WESTERN ELECTRIC COMPANY, Chicago, Ill., sent Messrs. E. W. Rockafellow and A. C. Morse.

DOSSERT & COMPANY, New York, was represented by Messrs. J. J. Dossert and A. H. Willmont.

THE LUNDIN ELECTRIC & MACHINE COMPANY, Boston, was represented by Mr. E. C. Lundin.

AMERICAN ELECTRICAL WORKS, Providence, R. I., sent Messrs. T. B. Baker and W. J. Watson.

RICHMOND ELECTRIC COMPANY, Richmond, Va., sent Mr. W. H. A. Davidson as its representative.

DOUBLEDAY-HILL ELECTRIC COMPANY, Pittsburg, was ably represented in the person of Mr. C. P. Hill.

COOPER HEWITT ELECTRIC COMPANY, New York, had its interests looked after by Mr. G. C. Ewing.

MARSHALL-SANDERS COMPANY, Boston, had for its sponsors Messrs. Norman Marshall and S. A. Sanders.

HARVEY HUBBELL, Bridgeport, Conn., had an exhibit of his specialties which was in charge of Mr. T. S. McLean.

ALBERGER CONDENSER COMPANY, New York, was represented by Messrs L. R. Alberger and H. M. Montgomery.

J. G. WHITE & COMPANY, New York, was ably represented in the persons of Messrs. P. G. Gossler and H. J. Dowds.

HOLOPHANE GLASS COMPANY, New York, made its usual excellent showing. Mr. J. S. Codman was in attendance.

DIEHL MANUFACTURING COMPANY, Elizabethport, N. J., had its interests ably cared for by President B. C. Kenyon.

HOLTZER-CABOT COMPANY, Brookline, Mass., was represented by Mr. C. W. Holtzer, who took an active part in the proceedings.

THE STANDARD VITRIFIED CONDUIT COMPANY, New York, had an attractive exhibit presided over by B. S. Barnard.

NEW YORK & OHIO COMPANY, Warren, Ohio, sent Secretary W. D. Packard to look after the interests of the Packard lamps.

AMERICAN DIESEL ENGINE COMPANY, New York, was represented by Messrs. N. McCarty and J. D. McPherson.

SPEER CARBON COMPANY, St. Marys, Pa., had its general manager, J. S. Speer, stop at the Convention on his way to Maine.

WESTON ELECTRICAL INSTRUMENT COMPANY, Newark, N. J., sent Mr. G. H. Moseman to look after its interests.

C. S. KNOWLES, Boston, was represented by Messrs. C. H. Clark, D. Kennedy, G. Ober, G. S. Hutchins, J. Keefe and H. M. Saben.

AMERICAN DISTRICT STEAM COMPANY, Lockport, N. Y., was represented by Messrs. C. R. Bishop and H. C. Eddy.

BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, was represented by Mr. Le Roy P. Sawyer, manager of the Cleveland office.

McINTOSH, SEYMOUR & COMPANY, Auburn, N. Y., had an efficient representation in Messrs. J. A. Seymour and E. A. Merrill.

CHASE-SHAWMUT COMPANY, Newburyport, Mass., had its interests taken care of by Messrs. H. P. Moore and F. D. Masterson.

DE LA VERGNE MACHINE COMPANY, New York, was represented by Messrs. George Richmond, Seward Babbitt and H. Borgstedt.

MANHATTAN ELECTRICAL SUPPLY COMPANY, New York, sent Mr. J. W. McDonald to look after its interests at the Convention.

LOMBARD GOVERNOR COMPANY, Boston, sent its engineers, Dr. A. V. Garratt and Mr. R. B. Smith, together with Mr. R. N. Stafford.

JAMES G. BIDDLE, Philadelphia, the well-known dealer in electrical and scientific instruments, was a prominent figure at the Convention.

ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, had its interests well taken care of by Messrs. Charles Blizard and J. W. Cook.

ALBERT & J. M. ANDERSON COMPANY, Boston, was represented by Mr. A. Anderson. Mr. J. M. Anderson was also an occasional visitor.

THE OKONITE COMPANY, LTD., New York, had ample representation at the Convention in the persons of Messrs. W. L. Candee and G. T. Manson.

H. W. JOHNS-MANVILLE COMPANY, New York, made a large exhibit of its specialties, which was in charge of Messrs. J. Sachs and J. Humphreys.

NERNST LAMP COMPANY, Pittsburg, Pa., had among its delegates Messrs. G. C. Ewing, R. T. Vredenburgh, M. W. Hanks, E. R. Roberts and F. Gibbs.

SHELBY ELECTRIC COMPANY, Shelby, Ohio, sent Mr. C. W. Cartwright to represent it. One candle-power useful lights were distributed as souvenirs.

OSBURN FLEXIBLE CONDUIT COMPANY, New York, sent Messrs. C. E. Corrigan and S. B. Roulet to the Convention so that "Flexduct" would not be lost sight of.

THE BOSSERT ELECTRIC CONSTRUCTION COMPANY, Utica, N. Y., manufacturer of switches, switchboards, junction and outlet boxes, was represented by Mr. F. G. Scofield.

PHOENIX GLASS COMPANY, Pittsburg, had present in its interests Messrs. A. H. Patterson, and E. H. Peck, from the New York office, and E. P. Ebberts, from Pittsburg.

DEARBORN DRUG & CHEMICAL COMPANY, Chicago, Ill., was represented by President W. H. Edgar and Mr. W. B. McVicker, manager of the New York office.

GENERAL INCANDESCENT ARC LIGHT COMPANY, New York, had present in its behalf Messrs. P. H. Klein, A. Foster, F. Raymond, R. S. Hale and S. H. Blake.

WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, occupied a parlor on the first floor. Messrs. Layman, Godfrey, Faxton and Mustard were in charge.

NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., had Mr. M. E. Baird to represent it at the Convention and to explain all the good points of the National alternators.

LOCKE INSULATOR MANUFACTURING COMPANY, Victor, N. Y., displayed a number of types of its insulators, which formed a prominent part of the Pettingill-Andrews exhibit.

PASS & SEYMOUR, Solvay, N. Y., the well-known manufacturers of porcelain specialties, were represented by Messrs. B. E. Salisbury, J. W. Brooks, A. M. Little and W. B. Hall.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., sent Messrs. F. C. Crosby, T. E. Hughes, C. J. Marsh and W. C. Waldron to represent it at the Convention.

SUNBEAM INCANDESCENT LAMP COMPANY, New York, and the Fostoria Incandescent Lamp Company, Fostoria, Ohio, were represented by Messrs. F. S. Terry and B. G. Tremaine.

THE W. S. HILL ELECTRIC COMPANY, New Bedford, Mass., showed a complete line of its switchboards and panelboards. Messrs C. S. Mendell and T. N. White were in attendance.

MASSACHUSETTS ELECTRICAL CO. was ably represented by Messrs. C. E. Farrington, L. O. Dulcos and E. C. Green. An acceptable souvenir was distributed from the company's parlor.

SPRAGUE ELECTRIC COMPANY, New York, sent Messrs. H. G. Issertel, H. C. Farnsworth and A. Henderson, who looked after the company's interests in their usual efficient fashion.

NATIONAL CONDUIT & CABLE COMPANY, New York, had a delegation at the Convention including Messrs. G. J. Jackson, W. S. Eckert, F. S. V. Sias, J. B. Honan and J. A. McQuale, Jr.

THE HART MANUFACTURING COMPANY, Hartford, Conn.—President G. W. Hart was in attendance and made many new friends for the "Diamond H" switches manufactured by his company.

THE H. T. PAISTE COMPANY, Philadelphia. —Secretary E. A. Jenkins attended the Convention and interested many delegates in "P-K" rosettes and the other numerous specialties of his company.

JOHN A. ROEBLING'S SONS COMPANY was represented by Messrs. F. W. Harrington, G. W. Swan, M. R. Cockey, C. B. Cushing and A. Mann. They made no exhibit, but distributed souvenirs.

BRYAN-MARSH COMPANY, New York, was ably represented by Messrs. G. V. Williams, J. P. Williams, D. W. Eyman, E. H. Houghton, G. C. Keech, S. E. Doane, F. W. Godfrey and W. C. Ballda.

THE STANDARD ELECTRICAL MANUFACTURING COMPANY, Niles, Ohio, had the merits of its "Star" lamps most ably presented to many delegates by Secretary J. P. Gilbert, who attended the Convention.

HART & HEGEMAN MANUFACTURING COMPANY, Hartford, Conn., manufacturer of the well-known Hart switches, was represented by President Albert H. Pease.

GOULD STORAGE BATTERY COMPANY, New York, made no exhibit, but its representatives, Dr. W. E. Winship and Mr. E. L. Draffen, neglected no opportunity for sounding the merits of the Gould storage battery.

CROCKER-WHEELER ELECTRIC COMPANY, Ampere, N. J., had its interests well taken care of by Dr. S. S. Wheeler, President, A. L. Doremus, Secretary, and Messrs. R. L. C. Barnes, C. R. Metchcar and A. J. Newell.

THE STANLEY INSTRUMENT COMPANY, Great Barrington, Mass., exhibited a full line of its meters. The exhibition was in charge of Messrs. W. C. Andrews, S. O. Ochs, E. W. Gough, F. J. Alderson and F. W. Sanford.

SIMPLEX ELECTRIC HEATING COMPANY, Cambridgeport, Mass., made a splendid exhibit of the various devices in the electric heating art, which was in charge of Messrs. J. I. Ayer, A. W. Doe and C. W. Richards.

AMERICAN CIRCULAR LOOM COMPANY, Chelsea, Mass., distributed neat little souvenirs. Its representatives included Treasurer A. T. Clark and Mr. T. H. Bibber, of the home office, and Mr. R. B. Corey, of the New York office.

NATIONAL CARBON COMPANY, Cleveland, had a number of its representatives at the Convention, among whom were N. C. Cotabish, sales manager, and Messrs. H. Murray, J. C. Irvine, J. F. Kerlin, F. C. Park and A. D. Spear.

STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., occupied commodious quarters and had its usual large corps to look after its interests. Among these were Dr. F. A. C. Perrine and Mr. Ray D. Lillibridge.

MUNDER ELECTRIC COMPANY, Springfield, Mass., was ably represented by President C. F. Munder and Mr. C. J. Purdy, manager of the New York office, who interested many of the delegates in the good points of Munder lamps.

TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, was represented by Mr. C. A. Cotton.

A number of inquiries were heard for Manager W. H. Jacob, who has been a familiar figure at many of the previous conventions.

THE CONDIT ELECTRICAL MANUFACTURING COMPANY, Boston, was represented by President S. B. Condit, Jr., and F. W. Nason, who explained the features of the Elden circuit-breaker and distributed some very acceptable pocket-knife souvenirs.

THE PETTINGILL-ANDREWS COMPANY, Boston, exhibited a large line of its various specialties. A large force of its representatives was on hand, headed by Mr. C. B. Price. A copy of the Underwriters' Rules in a green leather pocket book was distributed as a souvenir.

THE STERLING MANUFACTURING COMPANY, Warren, Ohio, distributed through Stuart-Howland Company, their New England agents, an attractive souvenir in the shape of a tape measure enclosed in a celluloid case on which was data relative to the Sterling special lamps.

SAWYER-MAN ELECTRIC COMPANY, New York, displayed in public for the first time its "Lumino" lamp. The lamps are of 54 candle-power and were used to light a large candelabra in the main Westinghouse exhibit room. A full line of standard incandescent lamps was also shown by the company.

THE PHELPS COMPANY, Detroit, Mich., was in evidence at the Convention by an exhibit of "Hylo" lamps in charge of Messrs. W. E. Phelps and F. L. DuBroy. "Winking" lamps for sign work and the new "Lazy Man's" lamp were features of the display. The company's other well-known types were shown in great variety.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., made a very handsome exhibit in one of the parlors of all of its well-known specialties. The company was largely represented. Its efficient staff included Messrs. J. A. Smith, T. L. Sturgeon, J. C. Lott, F. S. Hunting, J. W. Hilgeman, J. Kent, A. A. Serva and J. O. Spear, Jr.

STUART-HOWLAND COMPANY, Boston, occupied parlors at the Vendome and made an interesting display of electrical specialties. Souvenir whist counters were distributed. Those in charge were Messrs. G. M. Stuart, A. H. Howland, A. E. Payne, C. R. Fish, Huntington Lee, C. B. Wetmore, J. Wilson, W. Merritt and H. De Steese.

THE CROUSE-HINDS COMPANY, Syracuse.—In addition to President H. B. Crouse, Messrs. A. F. Hiller, C. Blanding, F. M. Hawkins and S. S. Grady came on to look after the company's interests at the Convention. The company made no exhibit, but a number of "Harpoon" guy-anchors, which were shown in miniature, received much favorable comment.

THE ALLIS-CHALMERS-BULLOCK interests were looked after by Mr. Arthur Warren, assisted by Messrs. G. H. Berg, H. E. Rundlett, J. R. Jeffrey, E. W. Goldsmith, E. T. Pardee and W. N. Ober. The combined companies occupied handsome quarters on the parlor floor which were decorated with large photographs of notable plants and machines built by the various interests.

THE DUNCAN ELECTRIC MANUFACTURING CO., Lafayette, Ind., exhibited some of the latest types of direct-current indicating wattmeters, a special feature of which is the new visual bearing with threadless jewel post. The company also exhibited switchboard meters in various designs and finishes. The exhibit was in charge of Messrs. Thomas Duncan and William H. Sinks.

THE GENERAL ELECTRIC COMPANY made no exhibit, although it occupied a large parlor. On Friday a number of delegates visited the G. E. shops at Lynn, Mass., where they were accorded an interesting and profitable time. Among the General Electric men present were Messrs. J. R. Lovejoy, E. E. Gilbert, W. C. Fish, C. D. Haskins, E. H. Mullin, C. B. Davis, H. W. Hillman, C. T. Moseman, G. T. Bridgman, J. R. Prentice, A. F. Giles, J. B. Pevear, E. D. Mullen, A. D. Babson, E. E. Peaseley, A. W. Ives, J. S. Butler, P. D. Wagoner, D. R. Bullen, H. L. Monroe, F. G. Vaughan, R. Fleming, F. M. Laxton, J. C. Kalisch, W. J. Hanley, J. Scribner, W. T. Wooley, H. L. Monroe, A. D. Page, G. F. Morrison, W. F. Willcox, T. E. Bibbins, H. H. Crowell, J. P. Felton, F. M. Kimball, S. B. Paine, R. B. Hampson, C. B. Burleigh, J. A. Wilson, H. W. Brown, O. F. Brastow, C. W. Fletcher, A. H. Coffin, M. J. Fitch.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY made an interesting and elaborate display on the ground floor of a number of new appliances used in electric lighting and central station practice. The exhibit was in charge of R. L. Warner. A number of the officials of the company were in attendance, a complete list being as follows: Messrs. F. H. Taylor, Arthur Hartwell, W. H. Whiteside, R. L. Warner, C. B. Humphrey, W. F. Fowler, H. D. Bayne, C. W. Underwood, G. B. Dusinberre, D. E. Manson, Andrew Raeburn, C. C. Chappelle, Y. L. Brinsmade, H. P. Davis, F. F. Rohrer, C. W. Register, J. B. Comstock, Henry Watts, A. Goodby, George W. Pulver, Frank B. Erwin, O. T. Smith, C. E. Skinner, E. E. Arnold, F. E. Conrad, Francis Hodgkinson, J. H. Smith, Edwin Yawger, H. R. Stuart, R. L. Rathbone, C. S. Jennings, C. G. Wilson, S. M. Bramman, F. F. Breed, J. W. Lucas, C. L. Abbott, E. D. Mills, M. H Merrill, G M. Bates, R. S. Brown, F. S. Perry, G. L. Osborne, G. S. Gibbs.

Numerous other manufacturers and supply companies were also in evidence, among whom were the following: Federal Electric Company, Mr. W. H. McLain; Chicago Fuse & Wire Company, Messrs. W. E. Weinsheimer and R. W. Smith; Peerless Electric Company, Mr. A. Dunlop; De Laval Steam Turbine Company, Mr. C. Garrison; Benjamin Electric Manufacturing Company, Mr. B. G. Kodjbanoff; Safety Insulated Wire & Cable Company, Mr. F. B. Parsons; C. H. Whall & Company, Mr. F. R. Whall; Wheeler Reflector Company, Mr. H. C. Hawks; Crescent Gas & Fixture Company, Mr. H. S. Beaman; Kimmey Electric Company, Mr. C. A. Brown; Jandus Electric Company, Mr. E. L. Nash; Kinsman Electric Railway Supply Company, Mr. F. E. Kinsman; Ballou-Hutchins Electric Company, Mr. C. A. Ballou; Washington Carbon Company, Mr. J. S. Crider; Phillips Insulating Wire Company, Mr. A. N. Palmer; D. & W. Fuse Company, Mr. W. S. Sisson; R. D. Wood & Co., Messrs. C. W. Lummis and H. G. H. Tarr; Re-New Lamp Company, Messrs. H. Hastings and G. H. Smith; Tipless Lamp Company, Mr. R. S. Carrick; Crescent Insulating Company, Mr. L. F. Jackson; Magnet Wire Company, Mr. H. Hill; The Wire & Cable Company, Mr. E. F. Sise; Marion Insulated Wire & Rubber Company, Mr. J. L. Lucas; Novelty Electric Company, Mr. C. E. Trump; Emerson Electric Manufacturing Company, Mr. E. L. Barkhouse; Electric Material Company, Mr. A. L. Bosley; Power & Mining Machinery Company, Mr. F. P. Thorp; Warren Arc Light Company, Mr. J. A. Stewart; I. P. Frink, Mr. Frank Stout; Sibley & Pitman, Mr. F. S. Gardner; Adams-Bagnall Electric Company, Mr. G. A. Thomson; Standard Varnish Works, Mr. J. C. Dolph; Lawrence Gas Fixture Company, Mr. C. V. Daiger; Buckeye Engine Company, Mr. A. K. Ashworth; E. B. Latham Company, Mr. E. B. Latham; National Wire Corporation, Mr. F. B. Parsons; Page Electric Company, Messrs. J. P. Coghlin and F. S. Miller; New Britain Machine Company, Mr. R. S. Brown; Independent Incandescent Lamp Company, Mr. W. M. Rothschild; H. B. Camp, Mr. C. C. Baird; American Vitrified Conduit Company, Mr. S. A. Douglas; Wirt Electric Company, Mr. W. J. Thompson; Fred J. Lucey, of F. J. Lucey Company; Sampson & Allen, Mr. A. T. Sampson; T. F. Carey Company, Messrs. Thomas F. Carey and C. H. Currier; Hewes & Phillips Iron Works, Mr. Franklin Phillips; McMichal & Wildman Company, Mr. F. B. Wildman; Ansonia Brass & Copper Company, Messrs. R. A. Cowles and F. H. Sherwood; Nightingale & Childs Company, Mr. E. G. Crosley; Charles A. Schieren & Co., Messrs. G. H. Hamblett and E. A. Usina; American Steel & Wire Company, Messrs. R. K. Sheppard, V. Goldthwaite, F. A. Keyes and A. F. Walker; Gillender & Son, Inc., Mr. W. Croft, Jr.; India Alkali Works, Mr. C. P. Powers; M. K. Kendall & Co., Mr. M. K. Kendall; Packard Electric Company, Canada, Mr. G. C. Rough; White Automobile Company, Mr. T. H. Tucker; J. Wilkinson & Co., Messrs. L. C. Billings and H. L. Slade; Bates & Neilson, Mr. J. Neilson; National Pipe Bending Company, Mr. W. G. Ruggles; M. W. Dunton Company, Mr. F. Chapman; Dwyer Machine Company, Mr. E. F. Dwyer; Potter & Earle, Mr. J. L. Potter; Heine Safety Boiler Company, Mr. E. L. McGregory; New England Machine Company, Mr. F. W. Smith; Macbeth-Evans Glass Company, Messrs. E. S. Briggs and M. B. May; Gamewell Fire Alarm Telegraph Company, Mr. H. E. Stover; Fall River Machine Company, Mr. G. A. Irving; E. J. Electric Insulating Company, Mr. M. H. Stearns; Colonial Electric Company, Mr. W. F. Curtis; W. Frederick Swift & Co., Mr. J. H. Hallberg; Fields-Foulk Company, Mr. C. J. Fields; Standard Paint Company, Mr. L. G. Goodrich; Bryant Electrical Company, Messrs. W. C. Bryant and F. V. Burton; American Brass & Copper Company, Mr. Randolph Osborn; Standard Optical Company; Mr. J. E. Bowker; Alphaduct Manufacturing Company, Mr. Russell Dart; The Dale Company, Mr. John H. Dale; India Rubber & Gutta Percha Insulating Company, Messrs. William M. Habirshaw and James B. Ilson; Bates Advertising Company, Mr. C. D. Marsh; Lynn Incandescent Lamp Company, Mr. Webster Bruce.

OBITUARY.

CHARLES HENRY PLUNKETT, an electrical engineer well known in elevator circles, died June 12 at his mother's home, Hinsdale, Mass., of pulmonary tuberculosis. Mr. Plunkett was born in Hinsdale in 1876 and was educated in the public schools there and the high school at Pittsfield. After graduating from the high school he chose the profession of electrical engineer, and upon completing his studies went directly to the Sprague Elevator Company, New York. He was afterward connected with the Otis Elevator Company and the Marine Engine & Machine Company and had charge of the installation of many important equipments.

WILLIAM WALLACE, of pioneer arc lighting fame, died at Washington recently at the age of 79 years. Mr. Wallace was born in England in 1825, but came to this country when a young man and with his father established the firm of Wallace & Son, at Ansonia, Conn., manufacturers of copper and brass alloys. Becoming associated with Professor Moses G. Farmer, the firm began the manufacture of telegraph wire. At the Centennial Exposition in 1876 Mr. Wallace exhibited the Farmer-Wallace dynamo, and later on, devised the arc lamp with carbon plate electrodes, from which he is best known to the electrical fraternity.

JAMES A. MYERS, president and treasurer of the Robbins & Myers Company, Springfield, Ohio, died of typhoid fever at his home in Springfield on May 27. Mr. Myers was born at Jamestown, Ohio, in 1851, and was educated at the Bowersville Academy. He engaged in business in Springfield in 1876 and two years later became interested with Mr. Robbins in the iron foundry business. In 1889 the two men formed the present Robbins & Myers Company. In 1900 Mr. Robbins retired from the company and Mr. Myers became its president, which office he occupied up to the time of his death. The company entered the electrical manufacturing field in 1896, since which time Mr. Myers has been a vigorous factor in the field and has made a large number of warm friends among the members of the electrical fraternity. He was a very successful business man, the present prominent position of his company being due to his good judgment and energetic management. Mr. Myers leaves a wife and two sons.

JAMES A. MYERS.

PERSONAL.

MR. JOHN G. PHILLIPS, purchasing agent for the Hudson Valley Railway, has been appointed master mechanic of the entire system.

MR. J. C. McQUISTON has been appointed superintendent of the Westinghouse Companies' Publishing Department, with headquarters at East Pittsburg, Pa.

MR. MARK A. REPLOGLE has been retained as chief engineer by the Replogle Governor Works, Akron, Ohio, which will put on the market Mr. Replogle's new differential water wheel governor.

MR. ROBERT McF. DOBLE, the well-known consulting and supervising engineer of San Francisco, has joined the staff of the Abner Doble Company, manufacturer of tangential water wheels.

MR. CHARLES R. GUERTLER, of the Engineering Company of America, is making an examination of the route for the proposed Roanoke & Mt. Airy railway.

MR. EDWARD WESTON received the honorary degree of Doctor of Science from Stevens Institute on the occasion of the commencement exercises held last month.

MR. HIRAM FOLEY has resigned the position of electrician of the Mexican Central Railroad shops at Aguascalientes, Mexico, to return to the United States. Mr. Foley's present address is Peru, Ind.

MR. GEORGE A. DAMON was married on June 8 to Miss Henrietta B. Diller, of Chicago. Mr. Damon is the managing engineer of the Arnold Electric Power Station Company and has a host of friends in the electrical field.

MR. PAUL M. MOWREY has been appointed vice-president of the Engineering Company of America. Mr. Mowrey has been prominently identified with engineering and contracting work since 1888, when he became connected with the Edison Illuminating Company.

MR. RUDOLPH MIEHLING, who has been for some time past New York manager for the Walker Electric Company, of Philadelphia, recently resigned that position to accept the position of sales engineer with the Frank Adam Electric Company, St. Louis, Mo.

MR. LOUIS F. PHILO, for the past six years prominently connected with the Wesco Supply Company, has severed his connection with that company and accepted the position of assistant manager of sales with the Ewing-Merkle Electric Company, St. Louis, Mo.

MR. MASON D. PRATT has established an office at 18 North Third Street, Harrisburg, Pa., for the purpose of engaging in general engineering. Mr. Pratt is prepared to make surveys, plans and specifications, supervise construction of electric railway and power plants, water works plants, etc., and to make examinations of existing plants.

MR. JAMES W. LYONS, who has been an engine salesman with the Allis-Chalmers Company for several years, was recently appointed manager of the newly created power department of that company. Mr. Lyons' headquarters will be at the Chicago office and his department will control the sales of all steam engines, turbine-generator sets, condensers, air compressors and gas engines.

MR. C. C. TYLER has resigned the position of superintendent of works of the Westinghouse Electric & Manufacturing Company to accept the general superintendency of all of the works of the Allis-Chalmers-Bullock interests in the United States. Mr. Tyler's headquarters are at Milwaukee. He is recognized as an expert of high ability in everything pertaining to economical machine shop administration.

MR. B. FRANKLIN HART, JR., who has been associated with Mr. Edwin Burhorn, a well-known contracting engineer, has resigned his position with Mr. Burhorn and established the firm of B. Franklin Hart & Co., for the purpose of manufacturing boilers, tanks and all classes of plate steel construction work. The firm has fully equipped pattern foundry and machine shops in connection with the plate steel shops and is prepared to make castings of all kinds. Its headquarters are at 143 Liberty Street, New York.

TRADE PUBLICATIONS.

FAN MOTORS. Fort Wayne Electric Works.—A well-executed, pocket-size booklet containing illustrations and brief descriptive data of the complete line of Wood fan motors.

THE CURTIS STEAM TURBINE. General Electric Company.—Publication No. 9131, executed in the artistic style characteristic of G. E. literature and containing a very full description in detail of the Curtis turbine.

GAS AND GASOLINE ENGINES. The New Era Gas Engine Company, Dayton, O.—A general catalogue containing illustrations and descriptions of the horizontal gas and gasoline engines built by this company.

INTERIOR ARC LAMPS WITH DIFFUSERS. Fort Wayne Electric Works, Fort Wayne, Ind.—This is bulletin No. 1055, devoted to the Wood direct-current, constant-potential arc lamp equipped with a circular diffuser for interior lighting.

BUFFING AND GRINDING MOTORS. The Holtzer-Cabot Electric Company, Brookline, Mass.—Bulletin No. 307, containing an illustrated description of direct and alternating-current motors having shafts extended to form buffing spindles, and mounted on appropriate base with tool rests.

INTEGRATING WATT HOUR METERS. Duncan Electric Manufacturing Company, Lafayette, Ind.—A twelve-page pamphlet of standard size, containing illustrations and brief descriptions of the various classes of Duncan integrating watt-hour-meters.

MANUFACTURING PLANTS. Westinghouse Electric & Manufacturing Company.—A superbly executed book, 7½ ins. x 9½ ins., containing photographic views of the individual Westinghouse establishments, a complete group of all of them, interior view, and pictures of representative Westinghouse apparatus and installations.

AUTOMATIC SELF-CONTAINED ENGINES. Chandler & Taylor Company, Indianapolis, Ind.—A catalogue of standard size, designated "Series E-1," and containing a detailed illustrated description of the new simple and compound horizontal engines brought out by this company for electric light and power service and other exacting classes of work.

ENGINES AND BOILERS. The James Leffel Co., Springfield, Ohio.—This is a handsomely executed catalogue of standard dimensions, opening endwise, and containing a detailed and profusely illustrated description of the Leffel throttling and automatic horizontal engines and horizontal return tubular boiler of the internally fired and ordinary types.

COOPER-CORLISS ENGINES. The C. & G. Cooper Company, Mt. Vernon, Ohio.—A collection of artistic half-tone engravings on heavy plate paper, illustrating the various types of Cooper-Corliss engines and some notable installations of them. Two of the engravings are of large size and sufficiently handsome to amply justify framing. These show three 250-h.p. Cooper-Corliss engines direct-connected to alternators in the power house of the Aurora, Elgin & Chicago Railway Company and a 1200-h.p. engine driving a direct-current generator in the power house of the National Cash Register Company, Dayton, Ohio.

BUSINESS NEWS.

THE ELECTRIC STORAGE BATTERY COMPANY has taken a residence at 4472 Forest Park Boulevard, St. Louis, for the use of the members of its staff attending the Exposition.

THE F. BISSELL COMPANY, Toledo, Ohio, calls the attention of the trade to the fact that it not only builds special switchboards for theaters, but also manufactures a special switch for theater service.

B. F. STURTEVANT COMPANY, Boston, Mass., announces that the removal of its plant from Jamaica Plain to the new works at Hyde Park, Mass., has been completed and the company is in position to handle all orders promptly.

GEORGE W. LORD COMPANY, Philadelphia, Pa., manufacturer of Lord boiler compounds, is distributing copies of an interesting photograph which shows a shipment of Lord's boiler compound in transit on crude wagons pushed and pulled by East Indian laborers in Madras.

ENGINEERING COMPANY OF AMERICA, New York, which has heretofore been engaged in purely professional work, has embarked in general engineering, construction and contract work in addition and is prepared to undertake all kinds of general contracting.

ABNER DOBLE COMPANY, San Francisco, manufacturer of tangential water wheels has organized a consulting engineering department and is prepared to take charge of the design and construction of power plants, pumping plants and other engineering work.

THE LUNKENHEIMER COMPANY, Cincinnati, on June 16 served a luncheon at its new manufacturing plant to delegates of the Ohio State Convention of the National Association of Steam Engineers, who visited the plant on invitation and were shown through the entire works after luncheon.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, has an attractive exhibit in the Steam, Fuel and Gas Building at the St. Louis Exposition, consisting of a display of tube cleaners and other boiler-room specialties, located directly in front of the line of boilers exhibited in the building mentioned.

CROCKER-WHEELER COMPANY, Ampere, N. J., announces that the well-known firm of Dodge & Day has been retained by the company for the purpose of giving its customers the benefit of the firm's wide experience and large collection of data accumulated during several years of active work in modernizing manufacturing establishments. No charge is made to Crocker-Wheeler customers for this expert service.

CROUSE-HINDS COMPANY, Syracuse, N. Y., informs us that at the Elks' Convention to be held in Cincinnati, July 8 to 25, there will be used nearly 30,000 Norbitt porcelain temporary sockets for decorative purposes, illuminating the streets for a distance of 37 blocks. More than 500 Norbitt sockets will also be used in making a huge illuminated flag to be hung over Government Square.

A CORRECTION.—On page 317 of our June number the Standard Underground Cable Company, of Pittsburg, was erroneously referred to as the "Stanley" Underground Cable Company in an item describing the joint exhibit of this company and the McRoy Clay Works at the St. Louis Exposition. As the Standard Underground Cable Company is well known in electrical circles all over the world, and as there is no such concern as the "Stanley" Underground Cable Company, the error probably caused no confusion, but it was, nevertheless, regrettable.

RHODE ISLAND ELECTROMOBILE COMPANY, Providence, R. I., recently made a trial run with forty cells of its automobile battery in an old motor vehicle over the roads between Providence, R. I., and Boston, Mass., the results of which were extremely satisfactory. On level roads the discharge averaged 30 amperes and on the hills between Pawtucket and Boston it ranged from 60 to 70 amperes. The weight of each cell was 29 pounds and the maximum ability 200 ampere-hours. The run to Boston and an additional run of about 30 miles around the city was made on a single charge.

AUTOMATIC ELECTRIC COMPANY, Chicago, has recently received important contracts, among which may be mentioned two for automatic equipments to replace manual systems in the cities of Battle Creek, Mich., and Van Wert, Ohio. The Battle Creek exchange is owned by the Citizens' Telephone Company, of Grand Rapids, who substituted automatic apparatus last winter for the manual exchange in Grand Rapids. The Battle Creek exchange is to have an immediate capacity of 1000 instruments, with an ultimate capacity of 10,000 The Van Wert exchange is to have an immediate installation of 925, with an ultimate capacity of 10,000. The company extends a cordial invitation to members of the electrical fraternity to visit its headquarters at Section 24, Palace of Electricity, St. Louis Exposition.

CENTRAL STATION NEWS

ALABAMA.

WYLAM.—The question of erecting an electric light plant and water works is being discussed here.

SYLACAUGA.—The citizens recently voted to issue $20,000 in bonds for the construction of an electric light plant and water works.

BIRMINGHAM.—It is understood that a power plant is proposed, but the plans concerning the size and details of construction are not yet matured.

JASPER.—A franchise for the operation of an electric railway has just been granted to the Jasper Water, Light & Power Company, of which Mr. J. M. Crawford is manager.

ATHENS.—The city authorities are contemplating the erection of a larger plant, as the present one is not capable of developing sufficient power to meet the demands. Mr. Samuel White is superintendent.

MONTGOMERY.—The Citizens' Light, Heat & Power Company recently announced the completion of its plant which went into operation the early part of June. The machinery is all in duplicate, thus insuring reliable and efficient operation.

OPELIKA.—The Opelika Railway, Light & Power Company was recently organized with a capital of $300,000. The following officers have been elected: President, Mr. J. B. Green; first vice-president, Mr. Rush Taylor; second vice-president, Mr. Bartow Smith; secretary and treasurer, Mr. W. C. Robinson. It is proposed to construct an electric railway from this city to Auburn and furnish lighting and power current for both places.

ALASKA.

SITKA.—It is the intention of the W. P. Mills Company to install an electric light plant in this city.

SEWARD.—Mr. Albert Dickinson, Mr. George Bohns, Mr. Harry Kennedy and Mr. W. E. Catzdanner have secured a franchise for the construction and operation of an electric light plant at this place. The active work of construction of a 1700-light plant is now under way.

ARIZONA.

NOGALES.—Mr. V. P. Maloney is now chief engineer of the Nogales Electric Light, Ice & Water Company. The company also furnishes lighting current to the town of Sonora, Mexico.

FLAGSTAFF.—The Flagstaff Electric Light Company expects within the next few months to add to its equipment a new generator, engine and boiler, in order to be able to supply current for street lighting purposes. Mr. G. T. Herrington is manager of the company.

ARKANSAS.

PARAGOULD.—Mr. P. D. Roe has been made manager of the Crystal Ice Company, successor to the Paragould Electric Light Company.

PINE BLUFF.—The Citizens' Light & Transit Company is considering placing an order for a 250-kw. or 300-kw. alternator for its plant.

SILOAM SPRINGS.—The municipal electric light plant is extending its lines and expects to make improvements which will double the capacity of the plant.

LEWISVILLE.—The Lewisville Light & Water Company has been incorporated for the purpose of constructing and operating an electric light plant, ice factory, steam laundry and water works. The company is capitalized at $25,000; Mr. E. B. Daniel is president, and Mr. G. W. Dobson, secretary.

FAYETTEVILLE.—Bids are wanted for a two-Phase, 120-kw. alternator to be operated either by steam turbine or direct-connected engine. It is understood that a day circuit both for light and power will be added, and other improvements are being considered. Mr. F. W. Fratt, of Oklahoma City, O. T., is owner of the plant. Mr. J. W. McLendon is superintendent.

DE QUEEN.—The following-named gentlemen are officers of the De Queen Light, Ice & Cold Storage Company: Mr. J. S. Lake, president; Mr. G. B. Pride, vice-president; Mr. George T. Scott, secretary and treasurer; Mr. A. P. Cone, manager; Mr. Elmer Mellott, chief engineer, and Mr. E. F. Chaffin, chief electrician.

BRINKLEY.—The Citizens' Light & Power Company is now known as the Farrell Light, Heat & Water Company. The company has a capital stock of $50,000, fully paid in, and has recently erected a new plant. It is officered as follows: Mr. J. J. Farrell, president; Mr. M. A. Farrell, secretary and treasurer; Mr. A. Rutherford, superintendent; Mr. W. Matthews, chief electrician.

MALVERN.—Some improvements are contemplated by C. W. Turner & Co., proprietors of the electric light plant, formerly known as the Malvern Light & Power Company. These will include a new dynamo and a new boiler. The following are the officers of the Company: President, Mr. C. W. Turner; vice-president and secretary, Mr. Lloyd Turner; treasurer and manager, Mr. C. W. Turner, Jr.; chief engineer and electrician, Mr. Joseph Brown.

CALIFORNIA.

PALO ALTO.—Mr. W. S. Barnhisel has been elected chief electrician for the municipal plant of the Palo Alto Company.

SEBASTOPOL.—Mr. G. W. Swain has been granted a franchise for the construction and operation of an electric light plant.

SPRINGVILLE.—The Globe Light & Power Company proposes erecting a new power plant between this city and the club house.

OXNARD.—The Oxnard Light & Power Company is preparing plans for an electric power house and plant. Major A. J. Driffill is president of the company.

SANTA ROSA.—The stock of the Merchants' Light Company has been purchased by the California Gas & Electric Company and its properties and business are now owned by the latter company.

WATSONVILLE.—The Watsonville Light & Power Company has been incorporated. Among the incorporators are Messrs. Fish M. Ray, Oakland; Joseph C. Love, Berkeley, and David H. Foote, San Francisco.

OAKLAND.—It has been recommended by the Street Lighting Committee that the contract for lighting the streets of Oakland for the ensuing year be given to the Oakland Gas, Light & Heat Company at $7.25 per month.

MONTEREY.—Mr. C. W. Allen is now manager of the Monterey Gas & Electric Company. The company is a consolidation of the Salinas Water, Light & Power Company and the Monterey-Pacific Grove Railway Company.

SAN FRANCISCO.—The Mt. Lassen Water Power Company has been incorporated with a capital of $50,000, by Messrs. Archibald Barnard, L. M. Robbins, A. G. Sheath, and others. The headquarters of the company will be in this city.

TUOLUMNE.—Articles of incorporation have been filed by the Central California Electric Company for the purpose of operating in Tuolumne County. The capital stock is placed at $500,000. Messrs. J. L. Gibbs and J. E. Conde are the incorporators.

YREKA.—The Siskiyou Electric Power Company has purchased the plant and business of the Aetna Electric Light Company and is now engaged in extending the main power line from Fort Jones through Greenview to Aetna, a distance of 12 miles.

BLUE LAKE.—Mr. C. D. G. Miller, president of the Eureka Lighting Company, accompanied by parties from Los Angeles and San Francisco, recently made a trip to the south fork of Trinity River with a view to locating a site upon which to erect a large power plant.

SAN BERNARDINO.—The Arrowhead Construction Company, which is building a large dam near this place, has just let the contract for the concrete core wall. The completion of this dam will make it possible to develop several thousand horse-power, which will be used for electrical purposes.

SAN FRANCISCO.—The Mutual Electric Light Company, with officers at 627 Howard Street, recently called a meeting of its stockholders to vote an issue of $400,000 in bonds, $250,000 to be sold for improvements and the remaining $150,000 to be held in the treasury until such time as it is needed.

SANTA MARIA.—The Santa Maria Power & Lighting Company has been incorporated with a capital of $50,000 to supply electric light and power to Santa Maria. The directors are Messrs. H. T. Duff, W. F. Gibbs, R. H. Pallard and F. C. Armstrong, of Los Angeles, and Mr. B. E. Page, of Pasadena.

LOS ANGELES.—The Los Angeles Lighting Company and the Los Angeles Electric Company have been consolidated by the Pacific Lighting Company, to reduce operating expenses, under the name of the Los Angeles Gas & Electric Company, which was recently organized with an authorized capital stock of $5,000,000, of which $4,000,000 has been issued.

NEVADA CITY.—The Nevada County Electric Power Company was recently absorbed by the California Central Gas & Electric Company, which, in turn, is now controlled by the California Gas & Electric Company. Mr John Martin is president; Mr. John A. Brown, vice-president and general manager; Mr. C. W. Conlisk, secretary, and Mr. R. M. Hofaling, treasurer.

LOS ANGELES.—The large engine in the Inglewood plant of the Edison Electric Light Company recently tore its crank boxes to pieces, leaving Long Beach in darkness until ten o'clock, when power from the Santa Monica plant was cut in. The engine was badly wrecked and power will be secured from the Pacific Electric Company until repairs at Inglewood are completed.

MENTONE.—The power plant of the Mentone Power Company, a branch of Huntington's Pacific Light & Power Company, is nearing completion and it is expected that within another month it will be in operation. The power house itself has been completed and part of the machinery is being installed; the transmission line to Los Angeles is also complete. The cost of the plant is estimated at $25,000. Nearly all the power furnished will be utilized by the Pasadena and Los Angeles trolley cars.

TULARE.—The electric plant at this point is a sub-station of the Mt. Whitney Power Company, whose main station is located at Visalia, a few miles north of here. Mr. Fred Hamilton is superintendent of the Tulare plant. Mr. Frank O. Smallwood, who has for a number of years served as engineer here, has been promoted to a position in the new main power house on the Kaweah River. Mr. Ray Holmes succeeds him in the sub-station.

FERN.—The new power plant of the Northern California Power Company on Cow Creek, near here, is nearing completion. One of the 2000-h.p. generators has been installed; the four-mile flume and ditch, taking water from Cow Creek, are finished, and work is being pushed on the three-acre reservoir at the head of the pipe line. The plant will be capable of developing 4000 horse-power, which will supplement the current now generated at the Shingletown plant of the company. The two plants are connected with all the power lines extending over Shasta, Tehama and Glenn Counties.

SAN FRANCISCO.—Mr. Harry L. Shannon, of this city, who is promoting a new electric power

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

system in Shasta County, hopes to have the first 1500-h.p. unit in operation by January 1. The ditches, flumes and pipe and pole lines will have a capacity of 3000 horse-power, and later, as the market justifies, the second unit of 1500 horse-power will be installed. Water will be diverted from Hat Creek just below Mt. Lassen and conveyed thence by ditch and flume, a distance of five or six miles, to Bear Creek. The pipe line will then be extended down Bear Creek to a point in the neighborhood of Bear Creek Falls. Here a fall of 1500 feet can be obtained in a distance of 6000 feet, developing 5000 horse-power.

SAN FRANCISCO.—More than half of the 500,000 shares of the North Mountain Power Company, which was incorporated for the purpose of developing an electrical power plant on the Smith River to supply Eureka and the adjacent towns, has been subscribed, and work has begun. The necessary machinery, wires and insulators have been ordered, and the water rights and ditches of Compagnie Francaise, a French mining company, have been purchased. Immediately upon completion of the initial line into Eureka, work will begin upon the company's water rights on the south fork of the Trinity in Trinity County and upon all the branches of the Smith in Del Norte County. The company was incorporated in 1902 with a capitalization of $500,000, the principal stockholders being Messrs. John H. Vance and William Carson, of Eureka, and Messrs. John L. Koster, Fred J. Koster, D. G. Scofield, W. H. Metson and Robert J. Tyson, of San Francisco. The office of secretary, Mr. Robert J. Tyson, has been established at 18 California Street.

COLORADO.

GOLDEN.—Mr. R. R. Morrill is now chief engineer of the Golden Illuminating Company.

LAMAR.—Mr. F. A. Dowler is chief engineer and electrician of the Lamar Electric Company.

GEORGETOWN.—Mr. L. C. Coggshall has been made chief engineer for the United Light & Power Company.

SALIDA.—Mr. J. Seligman has been elected president of the Edison Electric Light Company of this place.

MONTE VISTA.—Mr. N. H. Chapman is president and manager of the Monte Vista Electric & Gas Light Company and Mr. T. D. Shilling is now chief engineer.

DENVER.—The Colorado Power & Irrigation Company has secured a location on Grand River for the erection of two power plants, a main plant capable of developing 15,000 horse-power and a small auxiliary plant of 5000 horse-power. Work has been commenced on the site, but it will probably be a year before the plants are ready for operation and no contracts for machinery have been let as yet. Current will be transmitted 100 miles for mining and lighting purposes, metallurgical processes and irrigation.

CAUM CITY.—The Colorado Electric Power Company, which a year or two ago bought the plant and property of the Caum City Electric Light & Power Company, is now operating two sub-stations in the Cripple Creek district, supplying power to the mines of Cripple Creek and Independence. The company is officered as follows: Mr. D. V. Donaldson, president; Mr. J. H. Lenet, vice-president; Mr. Walter Scott, secretary; Mr. J. V. Hayes, treasurer, all of Colorado Springs; Mr. William T. Wallace, Caum City, manager and superintendent, and Mr. O. J. Rundahl, chief engineer.

CONNECTICUT.

THOMASTON.—The work of excavating for the new electric light plant has begun. The main building will be 71 feet long by 40 feet wide.

STAMFORD.—Mr. G. B. Leland, formerly with the Norwich Gas & Electric Company, has assumed the management of the Stamford Gas & Electric Company, of this city.

WATERBURY.—The New Milford Power Company, which transmits electric power from its plant at Bull's Bridge to this city for consumption by the Connecticut Railway & Lighting Company, has found it necessary to substitute porcelain for all the glass insulators on the double line of aluminum wires. Much more satisfactory results are now obtained.

CANAAN.—Lawyer J. Henry Roraback, of this town, representing New Haven capitalists, has been securing options on water-power sites on the Konapot River, which is located a short distance across the state line in Massachusetts. It is proposed to erect a large power plant for the generaiton and transmission of electricity for lighting purposes in this city, Norfolk and other Connecticut towns.

NORWICH.—Mr. Francis S. Thayer, formerly superintendent of the Westerly Gas & Electric Light Company, Westerly, R. I., has been appointed superintendent of the Norwich municipal light plant. Mr. Thayer is 37 years of age. For thirteen years he was with the Narragansett Electric Company, nine years of which time he was superintendent of that company's gas and electric plants at Warren and Bristol. He is succeeded at Westerly by Mr. F. N. Clark, who has been connected with the plant there for the past seven years.

HARTFORD.—The Hartford Electric Light Company has secured the contract for lighting the city at $70 per lamp per year for a term of five years. The company has leased a tract of land on the Connecticut River front at what is known as Dutch Point, upon which a new power plant will be erected to supersede the present plant on Pearl Street. As the latter is some distance from the river, it is expected that a considerable saving in transportation, water supply and other factors in the operation of the plant will be effected. Much of the equipment at the old plant will be transferred to the new site.

FLORIDA.

ARCADIA.—The Arcadia Electric Light, Ice & Telephone Company is arranging to put its arc lights on a separate circuit.

JACKSONVILLE.—The contract for the 500-kw. turbine generator, to be installed in the municipal lighting plant, has been awarded.

BRAIDENTOWN.—The Manatee Light & Traction Company is preparing to install a series alternating-current arc system. The plant is superintended by Mr. H. G. Hare.

KISSIMEE.—Of the $17,000 bonds recently voted by the citizens, $7000 is to be expended in improvements to the electric light plant, with a view to increasing its capacity. Orders for part of the equipment have already been placed.

TAMPA.—Mr. H. Stuart Pratt has been made treasurer of the Tampa Electric Company; Mr. G. W. Wells is manager, and Mr. F. E. Fletcher, superintendent. The company is considering the advisability of increasing its capital stock by the amount of $100,000.

MONTICELLO.—The power house of the electric plant, owned and operated by Mr. J. M. Henry, of this city, burned down some time ago and has never been rebuilt. The town is greatly in need of a plant for furnishing street lights, and it is thought that the council will shortly take under consideration the erection of a plant for this purpose.

KEY WEST.—The consolidation of the Key West Electric Light Company and the Electric Light & Power Company, which had been rumored for some time, has become an established fact. New machinery has been ordered for the plant of the Key West company, which will continue to furnish lighting and power current, while the other plant will be operated for the manufacture of ice.

GEORGIA.

CARROLLTON.—Mr. Charles Coats is now chief engineer for the Carrollton Electric Company.

CAMILLA.—Mr. J. E. Bishop is chief electrician for the Mitchell County Fertilizing Company, which has the city lighting contract for the town.

TIFTON.—The Tifton Ice & Power Company states that it intends to install a larger engine and dynamo in its plant. Mr. G. M. Roberts is manager for the company.

WASHINGTON.—The city authorities are considering the purchase of a 150-kw. two-phase generator for the lighting plant, and will probably install an electric pump at the water works.

CARROLLTON.—The citizens voted a couple of weeks ago to issue $45,000 in bonds for water works, a sewerage system and an electric light plant.

MILLEDGEVILLE.—Mr. Charles F. Howe, manager of the Oconee Electric Light & Power Company, writes that the company is contemplating improvements which will cost from $500,000 to $750,000.

BARNESVILLE.—A charter for the Flint River Power Company has been applied for by Messrs. G. E. Strickland, J. W. Strickland and associates, for the purpose of developing the property at Flat Shoals on Flint River, from which 5000 horse-power may be obtained.

GRIFFIN.—The City Council is considering the issue of $100,000 in bonds, $40,000 of which will be used for improvements to the lighting plant and water works, the remaining $60,000 to be expended in the installation of a sanitary sewerage system. Mr. J. W. Hammond is superintendent of the electric light plant.

ALBANY.—The City Council of Albany has under consideration a contract with the Albany Power & Manufacturing Company for the purchase of 300 electrical horse-power for a term of ten years for use in running the city's electric light plant and water works. If this contract is ratified, the Albany Power & Manufacturing Company will develop its water power on Muckafoonee Creek two miles north of the city, where it expects to obtain 2300 horse-power.

IDAHO.

BOISE.—Bids have been requested for lighting the city streets and buildings for a period of five years after August 1, this year.

GREER.—The dam and flume of the Lolo Creek Power Company, which was built at a cost of $25,000, was recently washed away by high water, entailing a loss of $10,000. The plant furnished electricity for a lighting plant and mills at Nez Perce. The damage will be repaired as soon as possible.

BOISE.—The capital stock of the Capital Electric Light, Motor & Gas Company is owned by the Boise-Payette River Electric Power Company and the power is all generated by that company at its water-power generating station at Horseshoe Bend on the Payette River, being delivered to the local company at its sub-station in Boise. Mr. O. E. Freeman is superintendent of the plant. The equipment at the generating station consists of two 500-kw. two-phase 200-volt 60-cycle Westinghouse generators. Current is transmitted 22 miles over a three-phase circuit at 22,000 volts, and distributed by means of Y-connected step-down transformers giving 2300 volts and distribution transformers, Y-connected, giving 115 volts.

ILLINOIS.

PANA.—The City Council recently called for bids for lighting the city requiring about 83 arc lights.

GOLCONDA.—A franchise has been granted for an electric light plant, to cost about $4000, of which Mr. J. O. Williamson is to be the manager.

ST. CHARLES.—The municipal electric light plant equipment will probably be increased this summer by the addition of a new Corliss engine and a generator.

LITCHFIELD.—Mr. David David, Mr. William La Force and Mr. Jacob J. Frey recently incorporated the United Gas & Electric Company with a capital stock of $100,000.

GALESBURG.—The work of constructing the large power house for the McKinley syndicate has been commenced. The building, which is to be 125x100 feet, will cost about $200,000.

KANKAKEE.—The Kankakee Electric Light Company will erect a concrete-steel dam across the Kankakee River this summer. Material for the dam is being delivered and active work on the construction will begin shortly. The cost is estimated at about $20,000.

OLNEY.—The officers of the Olney Electric Light & Power Company are: President, Mr. Aden

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Knoph; vice-president, Mr. W. H. Curnays; secretary, Mr. H. C. Hughes, treasurer, Mr. H. E. Hughes; superintendent, Mr. J. G. Hughes; manager and chief engineer, Mr. E. S. Hughes, and chief electrician, Mr. J. S. Hughes.

KANSAS.—The village lighting plant is erecting new poles and stringing new wires.

ROCKFORD.—The village lighting plant is erecting new poles and stringing new wires.

AMBOY.—The plant of the Amboy Lighting & Power Company is now in charge of Mr. W. A. Green as manager.

COLCHESTER.—A new engine is being installed in the plant of the Colchester Electric Light & Power Company.

OREGON.—Mr. W. L. Taylor is superintendent and chief electrician of the Oregon Electric Light & Power Company's plant.

TOLUCA.—The position of chief electrician for the Toluca Electric Light & Gas Company is now held by Mr. C. J. Walker.

ROSSVILLE.—Mr. Ezra Smock is now occupying the joint position of chief engineer and electrician of the electric light plant here.

ROCKFORD.—It is understood to be the intention of the Central Heat & Power Company to install a new electric plant this summer.

METROPOLIS.—Mr. William Gains is now chief engineer of the city electric light plant. A new 150-h.p. boiler is to be installed at the plant shortly.

QUINCY.—Plans have been perfected by the Quincy Gas & Electric Company requiring an expenditure of $50,000 for improvements during the coming summer.

QUINCY.—The Independent Light & Power Company will increase the capacity of its plant by adding another unit consisting of a 1200-h.p. engine and a large generator.

PAXTON.—The Paxton Electric Company was recently reorganized, but the officers have not yet been named. Mr. J. H. Preston is manager and chief electrician for the plant.

ALTONA.—The electric light plant formerly owned by Johnson & Hogg is now owned and operated by Mr. A. H. Johnson. Mr. Johnson superintends the plant personally.

LE ROY.—Mr. Morrell Tomlin, of this city, is now president and treasurer of the Le Roy Electric Light, Power & Heating Company. The company has the city lighting contract, which includes 25 arc lamps of 2000 candle-power.

CHICAGO HEIGHTS.—The Calumet & Harvey Lighting Company is a consolidation of the Calumet Lighting Company and the Harvey Illuminating Company. Mr. A. E. Walden is superintendent.

DANVILLE.—Mr. T. B. Macaulay has succeeded Mr. G. F. Duncan as vice-president and treasurer of the Danville Street Railway & Light Company, and Mr. Theo. Tillotson is chief engineer, succeeding Mr. C. L. Harry.

GALESBURG.—The work of laying the foundation for the new power house of the Galesburg Electric Motor & Power Company has commenced. The building itself will be constructed of brick and steel; orders for the machinery and other equipment have all been placed, and it is expected that the plant will be in operation about the 1st of September.

CHICAGO.—Edward Bruce Chandler died the morning of June 6 at his residence, 2512 Indiana Avenue, this city. He was born in Hartford, N. Y., in 1838. In 1858 he came to Illinois, being located at Springfield and Rock Island in the employ of the telegraph department of the Rock Island Railroad. Ten years later he came to Chicago to engage in the electrical business. Mr. Chandler was the first city electrician and held that position at the time of the fire of 1871 and for several years afterward. He was graduated from the University of Michigan, and was a member of the Beta Theta Pi Fraternity, of Chevalier Bayard Commandery, and of the Calumet Club.

INDIANA.

MT. VERNON.—The council is considering the question of constructing an electric light plant.

GOODLAND.—Mr. G. O. Thorpe is now superintendent of the Goodland electric lighting plant.

LINTON.—Mr. A. J. Todd is now superintendent of the city electric light plant.

DECATUR.—The equipment of the Decatur city lighting plant is to be increased by the addition of a 300-h.p. Corliss engine.

VEVAY.—Mr. Charles Holcroft is now manager of the Vevay Electric Light & Water Works and Mr. Peter Leep is chief electrician.

KNIGHTSTOWN.—The town authorities expect shortly to install a producer and substitute a gas engine for the present steam engine and boiler.

MUNCIE.—The Muncie Electric Light & Steam Heating Company is making preparations for the enlargement of its plant for furnishing steam heat.

CLINTON.—Mr. U. G. Wright is now secretary and manager of the Clinton Electric Light & Power Company, and the position of superintendent is filled by Mr. C. M. Poor, Jr.

NEW HAVEN.—All bids received by the Town Board for the construction of an electric light plant here have been rejected. New bids will be advertised for at once.

MONTICELLO.—Mr. L. M. Barnes is now proprietor and manager of the electric light plant formerly operated by Van Alstyne & Son. Mr. E. E. Van Alstyne is superintendent of the plant.

ENGLISH.—The English Light Company is understood to be owned by the Naylor Clark Handle Company. The plant has an ultimate capacity of 600 lights, but is carrying only 450 at present. Mr. J. F. Jones is superintendent.

MOORESVILLE.—The Public Service Company is advertising for bids for the construction of the power house for the water works and electric light plant, and states that the plans and specifications are ready for distribution among applicants.

GREENSBURG.—The Greensburg Gas Light Company has changed its name to the Greensburg Gas & Electric Company and increased its capital stock $30,000. The company will erect a plant and furnish electricity for lighting and power purposes in Greensburg.

ELKHART.—The St. Joseph & Elkhart Power Company contemplates important and extensive improvements, among which will be the extension of its system to Goshen, Laporte, Wakarua and Syracuse. The capital stock of the company has been increased from $50,000 to $250,000.

MT. VERNON.—The Mt. Vernon Electric Light & Power Company was recently incorporated with a capital of $5000. The directors are: Messrs. Jesse H. Purdy, George E. Hoffmaister, Harry B. Rhine and others. It is understood that bids for the construction of a plant will soon be asked for.

RICHMOND.—The following are the present officers of the Light, Heat & Power Company: Mr. R. S. Storrs, New York, president; Mr. J. W. Roney, secretary, treasurer and manager; Mr. James Abbott, New York, assistant secretary and treasurer; Mr. E. E. Witherby, New York, vice-president; Mr. B. C. Fowler, superintendent.

BOONEVILLE.—The City Light & Power Company has been awarded the city lighting contract and will push the work on its new plant as rapidly as possible. The contract, as accepted, is a liberal one in that it gives the city complete control, thus obviating the possibility of excessive rates in the future; the city also reserves the right to lease or purchase the plant at its option.

INDIANAPOLIS.—The city has just made a new contract with the Indianapolis Light & Power Company, by which it is entitled to 262 additional lights. The lamps will be placed as soon as it can be determined where they will do the most good. It is also the intention of the board to replace a number of the vapor lamps now in use with 50-c.p. incandescent lights. The vapor lamps have given considerable trouble by going out long before daylight and it has been decided to gradually replace them with incandescents.

INDIANAPOLIS.—The Merchants' Heat & Light Company is contemplating improvements and enlargements, by means of which the capacity of its plant at New Jersey and Pearl Streets will be increased 150 per cent. The cost of the proposed changes is estimated at $250,000 or $300,000. The present power house will be doubled in size and the new equipment will include additional boilers of 2500 horse-power capacity, equipped with chain grates, and two new 1500-h.p. Westinghouse turbine engines. Mr. James B. Nelson is manager and Mr. A. E. Durham superintendent of the company.

FORT WAYNE.—The sale of the plant and property of the Fort Wayne Electric Light & Power Company to Mr. J. W. Mayer, of Buffalo, and other eastern capitalists, was effected recently in consideration of $500,000. It is probable that in the near future the power and light company will be consolidated with the traction interests of the Fort Wayne & Wabash Valley lines. Mr. Mayer, who is also interested in the Lima, Ohio, Electric Railway & Light Company, and Mr. Charles W. Warner, of New York City, are now in the city taking over the affairs of the light and power company. It is understood that Mr. Charles G. Guild will be retained as manager.

WABASH.—The Wabash Water & Light Company has filed articles of incorporation with a capital stock of $160,000. The purpose of the company is to take over the plants of the Wabash Water Company and the Wabash Electric Light Company. The two former companies were owned by the First National Bank of New York, and for the past few years both plants have been managed jointly by Mr. Thomas W. McNamee, of this city, as superintendent. The company's charter is granted for a period of fifty years. The stockholders are: Messrs. Edmund LeB. Gardner, Ridgewood, N. J.; Whitney Conant, Paterson, N. J.; W. G. Shaw, Montclair, N. J.; Thomas W. McNamee, and Thomas McNamee; these constitute the board of directors. Mr. Thomas W. McNamee will continue in his position of superintendent. The plant has been recently enlarged and improved, and the company has no bonded debt.

INDIAN TERRITORY.

CHICKASHA.—The Chickasha Electric Light & Power Company has increased its capital stock to $45,000. Mr. James W. Hackaday is manager of the company.

PAULS VALLEY.—During a recent storm, fire was started in the electric plant owned by Thompson Brothers, almost totally destroying the plant. The loss is covered by insurance.

IOWA.

VILLISCA.—Mr. A. J. Jackson has been made chief engineer of the Villisca Electric Company.

IOWA CITY.—Mr. J. E. Tuttle is now superintendent of the Iowa City Electric Light Company.

IOWA CITY.—The J. F. Hill Electric Company, it is said, contemplates installing an electric light plant.

WILTON JUNCTION.—The citizens recently voted to issue $5250 in bonds for improvements at the electric light plant.

ALGONA.—The improvement of the electric light plant equipment by the addition of an engine and boiler is being discussed by the Countil.

WEST POINT.—The City Council is interested in the establishment of an electric lighting plant to the extent of securing estimates of the probable cost.

CENTERVILLE.—Mr. T. P. Shonty, Chicago, is now vice-president of the Citizens' Electric Light & Gas Company, and Mr. George Gawling has been made chief engineer.

BURLINGTON.—The Merchants' Light & Power Company was recently incorporated. The company will erect an electric light plant here with an initial capacity of 20,000 lights.

FORT MADISON.—The franchises recently granted to Mr. F. C. Wood for an electric light plant, an interurban railway system and a gas plant have been purchased, it is said, by Mr. Samuel Atlee.

LARNED.—Mr. C. W. Smith, proprietor of the Larned electric light plant, which has been supplying the city with light heretofore on a midnight schedule, proposes to make the necessary changes at his plant to enable him to operate on an all-night basis.

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MARION.—The contract of the Marion Light, Heat & Power Company for city lighting is about to expire and a new one is now under consideration. Mr. G. W. Toms is president and manager of the company; Mr. C. O. Ingersoll is secretary, and Mr. C. L. De Wald, chief engineer.

NEVADA.—Several improvements have been in progress at the plant of the Nevada Electric Light Company. An additional engine of 225 horsepower, with a dynamo of corresponding size, has been installed, necessitating the enlargement of the building. Concrete foundations have been put in for all of the machinery. The installation of the new machines provides a double equipment for the plant, insuring satisfactory service.

KANSAS.

CLAY CENTER.—Mr. F. A. Johnson is now general superintendent of the Clay Center Electric Light & Power Plant.

GARNETT.—Mr. Henry Myer is now manager of the Garnett Electric Light Company, which has the city lighting contract.

BLUE RAPIDS.—Mr. C. A. Axtell is chief electrician of the Electric Plaster Company, which has the lighting contract for the city.

BURLINGAME.—Mr. M. L. Morrison has succeeded Mr. E. H. Standard as manager and superintendent of the city electric light plant.

VALLEY FALLS.—Local reports state that the plant of the Roth Electric Light Company was seriously damaged by the spring floods and has since been idle. Mr. Roth, who operated the plant, has left the city and it is doubtful when the plant will be again in operation.

ARKANSAS CITY.—The officers of the Arkansas City Gas & Electric Company are as follows: Mr. W. M. Sleeth, president; Mr. H. P. Farrar, vice-president; Mr. Howard Ross, secretary; Mr. A. A. Newman, treasurer; Mr. J. H. Clay, superintendent. The company is supplying the city with current for thirty arc lights and also furnishes electricity for 75 commercial arc lights and 1500 incandescent lamps.

KENTUCKY.

DANVILLE.—The City Council has decided to receive bids for an electric light franchise.

ELIZABETHTOWN.—Mr. J. C. Stonfield is now chief engineer of the Elizabethtown Electric Light Company.

PINEVILLE.—Articles of incorporation have been filed by the Pineville Light & Ice Company, with a capital stock of $25,000.

ASHLAND.—The Ashland Electric Light & Power Company has been merged with the Camden Interstate Railway Company.

CALDWELL.—The Caldwell Electric Light & Power Company has filed articles of incorporation, stating its capital stock to be $15,000.

WICKLIFFE.—Mr. R. E. Gannon, of Cairo, is said to have secured the contract for an electric light plant for this city at $6042.

STURGIS.—It is stated that the town council is prepared to grant a franchise to parties who will construct and operate an electric light plant here. The town has a population of 1400.

SOMERSET.—A 250-h.p. Corliss engine and a 150-h.p. boiler have been added to the equipment of the city lighting plant. Mr. J. D. Holderman is in charge of the plant as superintendent.

FULTON.—The following officers of the Fulton Electric Light & Power Company have been elected: President and manager, Mr. L. W. Graham, and secretary and treasurer, Mr. A. L. Martin.

WILLIAMSBURG.—The Williamsburg Electric Light Company is now owned by the Nelson Brothers and Mr. P. Weesner. Mr. E. E. Nelson is manager of the company and Mr. Marshall Walls chief engineer.

HAWESVILLE.—The following are the present officers of the Hawesville Electric Light & Power Company: President and treasurer, Mr. I. C. Adair; secretary and manager, Mr. George C. Wilson, and chief engineer, Mr. George Wheeler.

LEXINGTON.—The Lexington Street Railway & Electric Light Company recently let a contract for a 600-h.p. gas engine to be installed in its power plant. Other improvements are being made at the plant, which will increase its capacity and make the equipment thoroughly modern.

HOPKINSVILLE.—The electric plant of the Hopkinsville Gas & Lighting Company was recently destroyed by fire, involving a loss which is estimated at $30,000, with $5000 insurance. The city will be seriously inconvenienced until the plant can be rebuilt, the streets and most of the business houses being in darkness in the meantime. It is understood, however, that plans are under way for a new building and that the contract has been let.

COVINGTON.—As soon as Mayor Beach and City Solicitor F. J. Hanlon issue the full text of the U. S. Supreme Court decision in the case wherein the right of Covington to build and operate an electric plant for lighting the city was established, the question of issuing $75,000 in bonds will be taken up. An expert will probably be engaged at an early date to prepare plans and estimates for a plant sufficiently large to supply electricity for the city and its citizens, and also to ascertain if the authorized bond issue of $75,000 would provide the necessary funds for that purpose.

LOUISIANA.

COVINGTON.—The St. Tammany Ice & Manufacturing Company, Ltd., has begun work on the enlargement of its electric plant here. This increase in capacity is necessitated by the large demand for light and power. Orders for the additional equipment have been placed and part of it has already been received.

VIDALIA.—The new municipal electric light plant, for which $15,000 in bonds was voted last year, has been turned over to the city complete. The cost of the plant was $10,000. The equipment consists of a 75-h.p. engine and an 85-h.p. boiler, and current is generated for 50 arc lights and 400 incandescent lamps.

OCEAN SPRINGS.—The work of installing an electric light system here has begun and will be pushed as rapidly as possible. There are to be 23 arc lights at the street crossings. The company, it is said, has agreed to furnish lights for the churches and the town hall gratis if the necessary wiring is done by the parties interested.

MAINE.

SOUTH BERWICK.—Mr. Charles W. Morse, of Hamilton, has been made president of the South Berwick & Salmon Falls Electric Company.

OLDTOWN.—It is thought probable that the big electric power house, for which partial preparation has been made, will be completed this season.

MARYLAND.

HAGERSTOWN.—Mr. J. O. Beard is now manager and superintendent of the municipal electric lighting plant.

MT. WASHINGTON.—The following have been elected officers of the Mt. Washington Light & Power Company: Mr. T. W. Offut, president and general manager; Mr. J. W. Jenkins, Jr., vice-president; Mr. H. J. McIntyre, secretary and treasurer.

CUMBERLAND.—The following-named gentlemen have been elected officers of the Piedmont Electric Light & Power Company: Mr. H. B. Carroll, president; Mr. Timothy Kenny, vice-president; Mr. Norris Bruce, secretary; Mr. W. W. Shultice, treasurer.

BALTIMORE.—Nelson Perin, who was the promoter of the present system of electric lighting in this city, died recently after a long illness, aged 51 years. Mr. Perin was one of the pioneers of rapid transit in Baltimore and was the first president of the United Railways & Electric Company which combined all the street railways of the city.

BALTIMORE.—The Maryland Telephone & Telegraph Company has begun to make use of its privilege of the city subways for supplying electric light and power. A force of men is at work drawing the cables through the conduits, and the current will be supplied for the present from the Purnell plant, which has been purchased by the company. Preparations are being made for the construction of a new central station at a cost of about $1,500,000, for which purpose the company is said to have obtained options on water-front property.

MASSACHUSETTS.

GLOUCESTER.—The Gloucester Electric Company expects soon to increase its plant equipment by the addition of a new 500-kw. steam turbine.

WOBURN.—Mr. C. L. Edgar, of Boston, is now president of the Woburn Light, Heat & Power Company, and Mr. C. J. Anderson is chief engineer.

MATTAPAN.—The Mattapan Gas & Electric Light Company of Boston was recently incorporated with a capital stock of $10,000. Mr. John H. Doherty is president of the new company.

TURNERS FALLS.—At a recent annual meeting of the Turners Falls Company it was voted to increase the capital from $300,000 to $600,000. It was also decided to continue the work of improving the power and building an electric plant. Mr. C. T. Crocker is president.

SPRINGFIELD.—At a recent meeting of the Board of Aldermen, it was recommended that another generator be installed in the electric light plant, and that proper provision be made for reserve capacity; that $3000 be furnished for new electric meters and as large a sum be appropriated for transformers.

MICHIGAN.

LAPEER.—Mr. F. J. Schlegel is now president of the Lapeer Light & Power Company.

BLISSFIELD.—Mr. R. H. Ellis is now superintendent of the municipal lighting plant.

CASS CITY.—Mr. W. N. Straube is now superintendent of the municipal electric light and water palnt.

NEGAUNEE.—Work has begun on the construction of the new gas and electric light plant for this place.

SAULT STE. MARIE.—The Edison Company is making preparations for the construction of an electric light station.

MILFORD.—Mr. F. S. Hubbell, owner of the electric light plant here, is arranging for improvements to his steam equipment.

MANTON.—Bids have been requested for repairing the electric light plant and water works. The cost is estimated at $5000.

OXFORD.—The village of Oxford is replacing the transformer now in use at its electric light plant with a machine of larger capacity.

BELDING.—Mr. J. E. Stanton is now occupying the position of chief electrician for the Spencer Electric Light & Power Company.

ITHACA.—It is said that the lighting plant and power plant formerly owned by the Ithaca Light & Power Company is now being operated by the village.

BRONSON.—William H. Friedrich & Co., owners of the electric light plant here, expect to build another mile of line and will install a new generator in their plant by fall.

CARO.—The Caro Light & Power Company, successor to the Caro Electric Light Works, has a paid in capital of $25,000. Mr. L. R. Peck is manager and superintendent.

MARSHALL.—Mr. P. S. Joy, superintendent of the Marshall lighting plant, writes that in all probability the old Brush arc dynamos will be replaced this summer by series alternating-current machines.

BATTLE CREEK.—Mr. Charles C. Green continues as president of the Citizens' Electric Company; Mr. F. A. Allwardt has been elected secretary and treasurer, and Mr. D. H. Beardsley is manager.

RAPID CITY.—Engineers are looking over the water-power sites on Rapid River with a view to constructing a plant to furnish electricity for lighting Rapid City, Alden and the resorts on Torch Lake.

CHELSEA.—Mr. B. Parker is secretary of the municipal electric light and water works; Mr. W.

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F. Riemenschneider is treasurer; Mr. C. W. Lightball, manager and superintendent, and Mr. W. H. Heselschwerdt, purchasing agent.

DETROIT.—The present officers of the electric light plant are as follows: President, Mr. E. H. McCurdy; vice-president, Mr. B. Grusburg; secretary, Mr. F. T. Bowler; manager and superintendent, Mr. William M. Daly, and chief engineer, Mr. W. F. Cullen.

KALAMAZOO.—The installation of 21 direct-current, enclosed-arc lights is being considered by the Council, and a new engine and boiler will probably be added to the equipment of the municipal electric light plant. Mr. E. W. Messany is superintendent of the plant.

SCHOOLCRAFT.—The power house of the village municipal electric lighting plant was destroyed by fire the morning of May 15. The plant had been in operation only since last December and the loss on machinery and buildings is estimated at $7000, about $5000 of which is covered by insurance. Steps will be taken to rebuild at once, but at the best the village will be in darkness for sixty days.

MUSKEGON.—Mr. George Erwin is said to be interested in the construction of three dams on Muskegon River, one at Rogers Bridge, another at the Davis Bridge, and the third still further down. It is estimated that about 10,000 horse-power can be produced. An electrical power house will be built at each dam and the current obtained will be transmitted to Grand Rapids, Big Rapids and Muskegon.

PENTWATER.—A contract has been closed between the village and the Oceana Electric Company, by which the company will operate the local water plant and will also install equipment to furnish twenty arc lights for the village and current for all private consumers at 50 cents per 32-c.p. incandescent lamp. The arc lights are to be of 1000 candle-power and to cost $75 per month for the twenty lamps. The plant is to be installed before December 31.

CONSTANTINE.—The Constantine Hydraulic Company has the city lighting contract for this city and Three Rivers. Each city has a sub-station in each of which are three 75-kw. step-up transformers by means of which the current is raised from 1100 to 2300 volts, and three step-down transformers for the reverse operation. Mr. George Flyten, Chicago, is president; Mr. L. J. Bolting, Three Rivers, secretary, treasurer and manager, and Mr. G. L. Shoup, this city, superintendent.

KALAMAZOO.—The Kalamazoo River recently formed a new channel around the southern end of the big dam at the Otsego power plant of the Kalamazoo Valley Electric Company, depriving the plant of its supply of water. As most of the cities between Kalamazoo and Jackson, as well as the Jackson-Battle Creek Interurban road, depend upon this plant for power, business was temporarily suspended while the Otsego dam was being disconnected from the others. It required about ten days to repair the damage.

DETROIT.—The Michigan Association of Electric Light Managers was recently organized in this city by managers of different lighting plants throughout the state. Mr. E. F. Phillips, assistant manager of the Edison Illuminating Company, of Detroit, was elected president, and Mr. F. S. Hubbell, of Milford, was chosen secretary. Several committees were appointed to take charge of the work of perfecting plans for future endeavor. Those present were E. F. Phillips, Detroit; J. B. Foote, Jackson; R. W. Hemphill, Ann Arbor; S. E. Padfield, St. Clair; A. R. McKennon, Cheboygan; F. L. Prindle, Gladwin; A. L. Pond, Coldwater; J. H. Kingsley, Manchester; G. A. Krause, Rockford; F. R. Gallop, Pontiac; F. S. Hubbell, Milford.

MINNESOTA.

ELY.—Mr. T. W. Tool is at present chief engineer of the city electric light plant.

GRAND RAPIDS.—Mr. O. P. Finis is now superintendent of the municipal electric light plant.

EXCELSIOR.—Dr. F. B. Kramer has petitioned for a franchise for an electric light plant and water works.

FULDA.—The Fulda Light & Water Plant (municipal) is now in charge of Mr. W. H. Blair as superintendent.

SOUTH STILLWATER.—The council has advertised for bids for the construction of an electric light plant.

LAKE CITY.—The municipal lighting plant will install a new engine and dynamo shortly, changing from direct to alternating current.

MONTEVIDEO.—The Montevideo Electric Light & Power Company is pushing rapidly its work of developing Minnesota Falls.

MADISON.—The city lighting plant is being improved by the installation of a new boiler and heater; a new system of piping is also being put in.

NEW PRAGUE.—A new engine and boiler are to be installed in the power house of the lighting plant here, bids for which were recently called for.

JANESVILLE.—Village Recorder L. D. Rogers writes that bids have been called for to construct an electric light plant and water works at a cost of $25,000.

FERGUS FALLS.—The Electric Light Commission has recommended the setting aside of $8000 toward rebuilding the dam which was destroyed a short time ago.

CHATFIELD.—Rev. S. Maddock has been made secretary of the Chatfield Electric Light & Power Company, to fill the vacancy made by the recent death of Mr. F. T. Drebert.

ROCHESTER.—The organization of a company to establish an electric plant to be operated from the water power at Jarrett is being discussed. The water power is owned by Mr. F. G. Colburn.

BELGRADE.—Mr. C. M. Iverslin is president of the village electric light and water plant; Mr. John Chisholm, secretary; Mr. A. J. Linquist, treasurer; Mr. P. B. Benther, manager and chief engineer.

THIEF RIVER FALLS.—The following are the present officers of the city electric light plant: President, Mr. M. C. Harlow; vice-president, Mr. Hans Langseth; secretary, City Clerk L. Backe, and superintendent, Mr. Leonard Peterson.

WHITE BEAR.—Amended articles of incorporation have been filed by the White Bear Electric Company, in which the capital stock was increased from $10,000 to $25,000. Mr. George H. Rief is president and Mr. F. E. Whitaker is secretary of the corporation.

LUVERNE.—The officers of the village electric light plant are as follows: President, Mr. E. A. Brown; secretary, Recorder E. C. Schwartz; treasurer, Mr. A. Ross; purchasing agents, Messrs. E. A. Brown, E. C. Shultz and George Leet; chief engineer, Mr. L. J. Chilbuck.

ST. PAUL.—The officers of the St. Paul Gas Light Company, which is now controlled by the Edison Electric Light & Power Company, are as follows: President, Mr. Emerson McMillan, of New York; vice-president and manager, Mr. Paul Doty; secretary and treasurer, Mr. John P. Crowley; and superintendent, Mr. H. J. Gilles.

DULUTH.—The Great Northern Power Company, of this city, has under way some very extensive improvements, by means of which it is proposed to have a 35,000-h.p. plant in operation in 1905, while the plans provide for an additional increase in capacity up to 80,000 horse-power. The company is now installing vertical turbines and other apparatus to operate at 250 revolutions per minute under a 365-ft. head, and another hydraulic installation of 12,000 horse-power at a 70-ft. dam is also contemplated.

CHISHOLM.—The Chisholm Light & Power Company, which recently filed articles of incorporation, expects to have its plant in operation shortly. Duluth will be the principal place of business of the company, which is capitalized at $20,000, and composed of Mr. Nils Anderson, of Virginia, Mr. Henry A. Liedel and Mr. Daniel D. Crowley, of this city. In addition to furnishing lighting and power current for the village, the facilities of the plant will also be utilized by the mines, which have heretofore used candles, and for the tripping work that is being done in the vicinity of Chisholm.

CLOQUET.—The Cloquet Electric Company has just closed a contract with the General Electric Company for a two-phase, 60-cycle, 2300-volt, alternating-current generator with direct-connected exciter to operate at 150 r.p.m., and with the Ball & Wood Company for a 14-in. and 28 in. x 27-in. Corliss valve compound condensing engine. The engine is to develop a horse-power-hour on 14 pounds of dry steam and 26 inches of vacuum. The engine builders are to forfeit $1000 for each pound or proportionate fraction thereof in excess of 14, pounds and are to receive a bonus of $1000 for each pound or proportionate fraction thereof saved in the economy thereof. The test will be made in September and will undoubtedly be watched closely by electrical and engine men.

MISSISSIPPI.

OXFORD.—The citizens have voted for improvements to the electric light plant.

BENOIT.—Mr. C. L. Lourey, an oil promoter, is said to be securing stock for a $100,000 oil mill, an electric light plant and water works.

BAY ST. LOUIS.—Mr. A. L. Stoker, proprietor of the electric lighting plant here, contemplates installing a new direct-connected engine and generator soon.

HATTIESBURG.—The City Clerk writes that the matter of constructing an electric light plant, for which $60,000 in bonds was to have been issued, has been postponed indefinitely.

CLARKSDALE.—Rather extensive improvements are under way at the municipal electric lighting plant, which will include a 400-kw. dynamo with the necessary steam equipment, together with a complete new switchboard.

WINONA.—The following are the officers of the Winona Water, Sewerage, Ice & Light Company: President, Mr. C. R. Kelso; secretary and manager, Mr. H. R. Romberger; treasurer, Mr. H. M. Romberger; chief engineer, Mr. William Dunnegan.

KOSCIUSCO.—The officers of the Kosciusco Oil Mill & Fertilizer Company, which owns and operates the lighting and power plant of this city, are as follows: President, Mr. W. B. Potts; vice-president, Mr. A. L. Dodd; secretary and manager, Mr. C. V. Jones; superintendent, Mr. Henry Miller, and chief engineer, Mr. L. Thomton.

BATESVILLE.—The Batesville Electric Light Plant, formerly owned by Mr. D. L. Rush, is now owned and operated by the Panola Electric Light & Power Company. The company expects to build a line to Sardis, nine miles distant, for the purpose of lighting Batesville by current transmitted from the Sardis plant. The Panola Electric Light & Power Company is capitalized at $25,000, and is officered as follows: Mr. A. W. Shands, Sardis, president; Mr. D. L. Rush, Sardis, secretary and superintendent; Mr. Monroe Pointer, Como, treasurer.

MISSOURI.

CARTHAGE.—Mr. A. P. Knowles has been made superintendent of the city electric light plant.

BETHANY.—Mr. J. F. Shuger is now manager of the municipal plant of the Bethany Light & Water Works.

SALISBURY.—A 100-kw. alternator and a 200-h.p. boiler are soon to be installed in the municipal electric light plant.

GALLATIN.—Mr. P. Love is now superintendent of the municipal electric light plant, Mr. J. J. A. Carter being chief engineer.

LOUISIANA.—The Louisiana Gas & Electric Light Company will probably make some improvements in its plant in the near future.

HANNIBAL.—Several contracts have been closed by the Board of Public Works for machinery, etc., for the new $100,000 municipal electric light plant.

BOLIVAR.—Mr. W. G. Smith has succeeded Mr. James Cruickshank as superintendent and chief engineer of the Bolivar Electric Light & Water Works Company.

VERSAILLES.—Bids were recently called for to furnish all labor, material and equipment necessary for the installation of a complete electric lighting plant in this city.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

WARRENTON.—The Warrenton Electric Company has been succeeded by the Electric Company of Warrenton, of which Mr. J. H. Frick is president; Mr. F. E. Schowengerdt, secretary, and Mr. Charles Schroeder, treasurer.

JOPLIN.—It was stated recently that an election was to be held to vote for the issue of $30,000 in bonds to improve the municipal lighting plant. It is proposed to install a new generator, engine and boilers. Mr. J. R. McDonald is superintendent.

LAMAR.—The plant of the Lamar Light & Water Company is being operated to the limit of its capacity and there is a large demand for more lights. The company will either replace the present machinery with larger units or install a duplicate of the set now in use.

WEBSTER GROVE.—The Suburban Electric Light & Power Company now controlls the Electrical & Maintenance Company and the St. Louis County Electric Company. Current for lighting purposes is also furnished to Maplewood, Kirkwood and Greenwood. The following are the company's officers: President, Mr. C. C. Einstein; vice-president, Mr. Paul W. Coble; secretary and treasurer, Mr. H. C. Holmes; manager and superintendent, Mr. S. H. Wallace, and chief engineer, Mr. A. F. Covert.

SEDALIA.—The United Water, Gas & Electric Company, which is a consolidation of the Sedalia Water & Light Company, the Gas Company and the Street Railway Company's lighting plant, has filed articles of incorporation with a capital of $1,000,000. Messrs. Lewis M. Rumsey, Jr., Horace S. Rumsey and Joseph Clarke are among the incorporators. The company will construct, acquire, maintain and operate water works, gas works, electric lighting and power plants, street railways and steam power plants in and adjacent to the city of Sedalia.

NEBRASKA.

LINCOLN.—Electric light bonds to the amount of $65,000 have been sold.

FREMONT.—The council is considering making additions to the electric light plant.

ALBION.—Mr. C. M. Sinnard is chief engineer of the Albion Electric Light & Power Plant, which is owned by Mr. H. Rice.

TEKAMAH.—The electric light plant at this city was seriously damaged by a tornado on June 2, leaving the town in complete darkness.

CAMBRIDGE.—The Cambridge electric light plant, which has been operated under the management of Mr. P. B. Cole, has been organized as the Cambridge Electric Light Company with a capital of $10,000. Aside from the lighting plant, the articles of incorporation include the maintenance of a heating plant and a system of water works which will be put into effect later. The directors are Messrs. W. H. Faling, J. H. Rosenfelt, E. C. Rodwell and others.

NEVADA.

RENO.—This city is to have two water and power companies. Work on the opposition plant is to begin at once. Governor Sparks is the principal owner of the new enterprise and announces that the company will be prepared to furnish water and light not later than next spring. The company owns water rights on Hunter Creek, five miles north of the city.

VIRGINIA.—The Truckee River General Electric Company is making arrangements to install an additional plant of from 2000 to 3000 horse-power capacity, to be operated by water power. Surveys are also under way for a new 35-mile transmission line, and a new sub-station will be erected this summer. The headquarters of the company, formerly at San Francisco, is now in this city, where it has bought out the T. H. Electric Light Company and the Carson Light & Power Company. Mr. F. O. Broili is superintendent.

NEW HAMPSHIRE.

MILFORD.—Considerable progress is being made in the construction of the electric light service from here to Amherst.

MARLBORO.—The following-named gentlemen have been elected officers of the Marlboro Electric Light Company: Mr. O. A. Norwell, of Boston, president; Mr. Lewis H. Tiffin, Providence, treasurer; Mr. Edwin C. Mansfield, Meredith, manager.

PORTSMOUTH.—The board of tax assessors recently voted to assess the entire light and power plant of the Rockingham County Electric Light & Power Company of this city. When this plant, which is the largest in the state, was built the city voted to exempt all new work of the company from taxation for a period of ten years, and since then a plant has been developed which is estimated to have cost $500,000. The action of the assessors is based on a decision of the Supreme court that all votes of cities and towns exempting from taxation light and power plants are illegal and void. The company furnishes power for the New Hampshire Traction Company's electric road, with lines running as far as Nashua, Lowell and Haverhill.

NEW JERSEY.

VINELAND.—Mr. R. H. Garrison is now superintendent of the electric lighting plant of the borough of Vineland.

CAMDEN.—The Public Service Corporation Company has just been awarded a five-year contract by the Lighting Committee to supply 524 arc lights at $109 per year per lamp.

HADDONFIELD.—There is some discussion among the taxpayers of the town concerning the question of constructing and maintaining a municipal electric light plant and water works.

JERSEY CITY.—The Commonwealth Electric Company has been incorporated with a capital of $100,000 for the purpose of furnishing light, heat and power. The company's office is at 15 Exchange Place, Jersey City.

NEWARK.—Mr. D. Farrand, secretary and manager of the People's Light & Power Company which is controlled by the Public Service Corporation of New Jersey, has been elected secretary of the National Electric Light Association.

SUSSEX.—The Woodbourne Electric Light, Heat & Power Company recently elected the following officers: President, Mr. Charles A. Wilson; vice-president, Mr. C. H. Chrisman; secretary, Mr. A. W. Deldell; treasurer, Dr. H. D. Van Gassbeck.

BEVERLY.—The Cinnaminson Electric Light Company is now known as the Cinnaminson Electric Light, Power & Heat Company. The company also furnishes lighting current to Edgewater Park, Delanco, Riverside, Palmyra, Riverton and West Freehold. Mr. Charles Major is chief engineer.

NEWTON.—The contract has been let for the installation of a 300-h.p. plant for lighting the town. The equipment consists of two American Crossley two-cylinder horizontal gas engines of 200 and 100 horse-power respectively, direct-connected to 150-kw. and 75-kw. alternating-current generators.

NEW MEXICO.

CARLSBAD.—The Carlsbad Electric Light Plant, formerly known as the Eddy Electric Light Plant, is now owned by Mr. C. H. Klander.

ROSWELL.—The Roswell Electric Light & Power Company, which began operations recently, is preparing to extend its lines, material for which has been ordered. Mr. Maynard Gunsul, of Albuquerque, is president; Mr. C. M. Bird, secretary, and Mr. W. H. Pierce, manager and superintendent. It is understood that the company also controls the Gallup Electric Light Company, of Gallup, this state.

NEW YORK.

CAZENOVIA.—The Cazenovia Electric Company is installing underground circuits.

WARSAW.—Mr. W. E. Hemenway is now superintendent of the Warsaw Gas & Electric Company.

CLINTON.—Arrangements are being made for the construction of a municipal electric light plant.

GREEN ISLAND.—Mr. Daniel Catarius has been appointed superintendent of the village lighting plant.

LITTLE VALLEY.—Mr. C. P. Rice has been appointed superintendent of the village electric light plant.

NIAGARA FALLS.—The Niagara Falls Hydraulic Power & Manufacturing Company is contemplating the erection of a new power house.

PENN YAN.—Bids were recently advertised for to furnish boiler, engines, alternators, arc lamps, etc., for use in the municipal electric lighting plant.

SALEM.—The following are the officers of the Salem Electric Light & Power Company; Mr. George Austin, president; Mr. E. W. Philo, secretary and manager.

ALBANY.—The Albany Electric Illuminating Company is preparing to change from steam to water power. Mr. A. N. Brady is president and Mr. A. Anderson, manager and superintendent.

HUNTINGTON.—The Huntington Light & Power Company has recently installed new engines and dynamos for the purpose of furnishing power for the operation of the new Huntington trolley line.

KINGSTON.—Surveyors have begun the work of locating the line for the poles and wires to bring electrical power from the Honk Falls power plant to this city for the use of the Honk Falls Power Company.

BAY SHORE.—Mr. W. A. Wright, of New Haven, Conn., is president of the Suffolk Gas & Electric Company; Mr. W. S. Pardee, New Haven, is secretary and treasurer, and Mr. A. M. Hallock is superintendent.

NEWARK.—Mr. H. M. Whitehead, superintendent of the City Water Company of this city, has resigned his position with that company and assumed the management of the light and power plant at Port Jervis, N. Y.

GOWANDA.—Mr. W. R. Smallwood has assumed the management of the Gowanda Consolidated Electric Light & Fuel Company. It is understood that extensive improvements and alterations will be undertaken in the near future.

LOCKPORT.—A contract has just been closed with the Lockport Gas & Electric Light Company for lighting the city for a period of three years at $75 each for arc lights and $17.50 each for gas lamps; there are 300 of the former lights in use.

TROY.—The Troy Gas Company, which now controls the Beacon Electric Light Company, is installing in its station two 40-cycle synchronous motors, also a motor-generator set, the machines to be operated by power obtained from Spiers Falls.

GRANVILLE.—The Granville Gas & Electric Light Company has begun work on the construction of its dam at Lake St. Catherine. The company expects shortly to erect a line to Whitehall and will ask for a franchise to operate in that village.

NEW YORK CITY.—The Ramona Natural Gas Light, Heat & Power Company of New York City has been incorporated, with a capital stock of $100,000 and the following directors: Messrs. Howard McWilliams, A. L. Cohn and C. S. Steckmest, this city.

CLYDE.—Mr. George Brooks has been made superintendent of the Wayne County Electric Lighting Company's plant in this village, to succeed Mr. George Rodwell, who resigned his position here to accept one with the Syracuse Lighting Company.

MIDDLETOWN.—The Consumers' Light & Power Company has elected the following officers: President, Mr. J. G. Harding; vice-president, Mr. William Snyder; secretary, Mr. Isador Budwig; treasurer and manager, Mr. D. C. McMonagle; superintendent, Mr. C. S. Warner.

LOCKPORT.—Press reports state that the Niagara, Lockport & Ontario Power Company will build the canal under the present charter and seek an amendment next year, which will authorize it to sell power to all counties of the state instead of only Erie, Niagara and Orleans.

TANNERSVILLE.—Messrs. Jacob Fromer, Geo. Hanner and Cyrus Showers, all of Tannersville, recently organized the Tannersville Electric Light & Power Company with a capital stock of $20,000. The company will furnish electricity to the town of Hunter, Greene County.

JAMESTOWN.—Charles W. Grant died suddenly at his home in this city on May 10. Mr. Grant was one of the organizers and for many years the

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president of the Jamestown Electric Light & Power Company. He was 60 years old at the time of his death and leaves a widow and one daughter.

BATH.—Mr. Cameron Cotton, who for several years has been chief engineer at the plant of the Bath Electric Illuminating & Power Company, has resigned his position with that company. It is rumored that Mr. Cotton will be identified with the new electric light company which is soon to commence operations in the village.

SANDY HILL.—The preparations of the United Gas, Electric Light & Fuel Company for obtaining power from the Union Bag & Paper Company, of Bakers Falls, are nearly complete and it is probable that the villages of Sandy Hill and Fort Edward will be supplied with current for lighting and power purposes from the Bakers Fall plant.

MASSENA.—The St. Lawrence County Electric & Water Company is a consolidation of the St. Lawrence Telephone Company, the St. Lawrence Water Company and the Massena Electric Light & Power Company. The president is Mr. T. A. Gillespie; secretary and treasurer, Mr. E. B. Bumsted, both of New York City, and manager, Mr. A. E. Russell, of this city.

LE ROY.—The Le Roy Hydraulic Electric Company, the Le Roy Gas & Electric Company and the Le Roy Power & Milling Company, all of this village, have combined under the name of the Le Roy Hydraulic Electric Gas Company, the capital stock being fixed at $100,000. A number of improvements in the plants are to be made and the business considerably extended.

BROOKLYN.—The Kings County Lighting Company has been incorporated, with a capital stock of $2,000,000. The company will operate in Brooklyn and Queens boroughs, manufacturing and selling gas and electricity. Messrs. Ashley T. Cole and Charles T. Lark, New York City; William J. Bagnall, Bayonne, N. J.; Alexander Keogle, New Rochelle, and W. R. Fuller, Brooklyn, are named as the directors.

ADDISON.—The entire plant of the Addison Electric Light & Power Company was destroyed by fire recently. The pumping station near the electric light plant and the planing and saw mill of McElroy & Wheadon, who owned all of the property, were also burned. The loss is estimated at $50,000 and is total, there being no insurance. The plant will probably be rebuilt immediately.

ALBION.—The Albion Electric Light, Power & Gas Company, which also owns the electrical plants at Waterport, Brockport and Middleport, is said to be interested in a deal for the development of a large water power at the latter village, approximating 25,000 horse-power. It is proposed to purchase the paper mill site just north of the village and combine the power of that site with the water power sites on the creek below. The whole of the power thus obtained will be utilized for the generation of electricity.

NORTH CAROLINA.

MT. OLIVE.—Plans and estimates are being prepared for an electric light plant.

REIDSVILLE.—Mr. T. S. Murphy is chief engineer of the Reidsville Water & Light Plant.

GREENVILLE.—Bids for the construction of an electric light plant were recently advertised for.

LEXINGTON.—It has been voted to issue $60,000 bonds for the construction of water works, an electric light plant and for new pavements.

FAYETTEVILLE.—The city now owns its own electric light plant, and reports state that the demand for current has so increased of late as to make necessary improvements which will nearly double the capacity of the plant.

SHELBY.—Messrs A. W. McMurry and Hugh G. Miller, proprietors of the electric light plant of this place, contemplate rebuilding the plant and will probably change over from the present single-phase system to a three-phase system.

RALEIGH.—The following are the officers of the Standard Gas & Electric Company: Mr. S. E. Linton, president and manager; Mr. J. S. Carr, vice-president; Mr. H. W. Jackson, secretary and treasurer; Mr. C. F. Farmer, superintendent.

WILSON.—A charter has been granted to the Wilson Light & Power Company, recently incorporated with a capital stock of $125,000 by Messrs. J. C. Hale, B. F. Lane, Claudius Aycock, E. L. Armfield and David Daniels, for the purpose of maintaining a lighting and power plant.

GREENSBORO.—The Greensboro Electric Company operates the gas and electric plants and furnishes power for the street railway and city pumping. Mr. John Karr, of Hackettstown, N. J., is president of the company; Mr. Z. V. Taylor, secretary; Mr. M. D. Barr, treasurer; Mr. R. H. Gamwell, manager; Mr. A. H. Jones, superintendnet, and Mr. R. E. Pentecost, chief engineer.

SOUTHERN PINES.—It was erroneously stated in these columns last month that the electric plant of this town was owned by Mr. R. L. Chandler and known as the R. L. Chandler Electric Light Plant. This plant has only its office in this city and lights the towns of Troy and Biscoe. The Southern Pines plant is owned by Mr. I. F. Chandler and furnishes lighting current to the towns of Carthage and Aberdeen, besides Southern Pines.

ELIZABETH CITY.—The Elizabeth City Electric Light & Power Company was recently organized by the consolidation of the Electric Light Company of Elizabeth City, Elizabeth City Electric Light & Power Company and the Elizabeth City Water & Power Company. Mr. D. E. Evans, of Baltimore, Md., is president; Mr. W. T. Old, vice-president; Mr. H. Clay Tunis, secretary, treasurer and manager, and Mr. R. E. Lewis, superintendent. The company furnishes current for 316 city incandescent lights, 70 commercial arc lamps and 3100 commercial incandescent lights.

NORTH DAKOTA.

LIDGERWOOD.—The council is considering the construction of an electric light plant, and it is thought that the matter will be acted upon favorably.

WIMBLEDON.—The electric light plant has been purchased by Mr. Fred Zollner, of Courtenay, N. D., who will install additional machinery and otherwise improve the plant.

FARGO.—Mr. Harry Hoffman, who resigned his position as superintendent of the municiapl electric light plant last summer to accept a similar one near Spokane, has returned to this city and is again occupying his former position.

FARGO.—The Fargo Gas & Electric Company has been consolidated with the Fargo Edison Company under the name of the Union Light, Heat & Power Company. The officers of the new company are as follows: President, Mr. William Mainland, Oshkosh, Wis.; vice-president, Mr. J. W. Smith, Fargo; secretary, Mr. O. G. Barnes, Fargo; treasurer, Mr. Sinclair Mainland, Green Bay, Wis.; manager, Mr. O. G. F. Markhus, this city. The company is making improvements and addition to the plant, increasing the equipment and thereby the capacity.

OHIO.

HURON.—Mr. B. O. Brooks is chief engineer of the Huron electric light plant.

NORTH AMHERST.—Mr. H. W. Strauss is now chief engineer of the municipal lighting plant.

BAINBRIDGE.—A new dynamo is being installed in the Bainbridge electric light plant.

CELINA.—Mr. J. N. Houser has been made superintendent and chief electrician of the city lighting plant.

DELPHOS.—Mr. Pierce Kinsley is now superintendent of the Delphos Electric Light & Power Company.

WEST MILTON.—The Council has under advisement the question of establishing an electric light plant.

WELLSTON.—Mr. Thomas Morgan is now in charge of the city lighting plant as manager and chief engineer.

COLUMBIANA.—Mr. H. C. Fashbaugh is superintendent and chief electrician of the village lighting plant.

WILLIAMSBURG.—Report state that bids have been received for constructing an electric light plant and town hall.

TIFFIN.—Mr. Thomas Esty has been made superintendent of the plant of the Consolidated Gas & Light Company.

ORRVILLE.—The Orrville Light, Heat & Power Company is preparing to install an incandescent system of street lighting.

BEVERLY.—The plant of the Beverly Electric Light Company, formerly owned by Mr. I. A. Frost, is now operated by the city.

DOYLESTOWN.—The proposition to issue $10,000 of municipal lighting bonds is soon to be submitted to a vote of the citizens.

HILLSBORO.—The contract for lighting the city for a term of ten years has been awarded to the Hillsboro Light & Fuel Company.

MIAMISBURG.—Mr. Mott Ware has been elected president of the electric light plant and Mr. J. G. Jacobs is secretary and manager.

BELLEFONTAINE.—The town authorities expect to rebuild the entire electric light plant next year. Mr. C. W. Buchanan is manager and superintendent.

GLOUSTER.—Glouster is to have an electric light plant, the contract for the construction of which has been let to the Russell Engine Company for $16,422.

WEST MANSFIELD.—Contracts for the construction of an electric light plant will soon be let, bonds to the amount of $11,000 having been sold for the purpose.

GENEVA.—Mr. Charles H. Hawes has been made superintendent of the Geneva Electric Illumoinating Company, formerly known as the Geneva Lighting Company.

CONNEAUT.—Mr. J. K. Henderson is superintendent of the municipal electric light plant; Mr. John Lovell is chief engineer, and Mr. E. M. Marsh is his assistant.

SALEM.—The Salem Light & Power Company has been incorporated with a capital of $10,000 by Messrs. J. S. Klinefelter, J. G. Wilson, C. M. Wilson, E. N. Grove and others.

OBERLIN.—The Oberlin Gas & Electric Company recently completed the installation of a very complete steam heating system and plant, which is operated in connection with its electric plant. A. E. Hay is manager and superintendent.

ZANESVILLE.—The city authorities are considering the advisability of installing electrical apparatus in their present water works pumping station and generating their own lighting current. The city pays at present $20,000 per year for lights.

PRAIRIE DEPOT.—A franchise has been granted to Messrs. Harry L. and Charles H. Wilson, of Fostoria, for operating the electric light plant which has been idle for several months. The plant has been thoroughly repaired and is now in operation.

BRIDGEPORT.—The Bridgeport Electric Light & Power Company has elected the following officers: Mr. A. L. Snowden, of Philadelphia, Pa., president; Mr. H. T. Hartman, Philadelphia, vice-president, and Mr. John B. Gardner, Wheeling, W. Va., secretary and manager.

RIPLEY.—The electric light plant is now operated in connection with the gas plant under the name of the Ripley Gas Light & Coke Company. Mr. F. A. Stivers is president of the company; Mr. C. Baird, vice-president, and Mr. J. C. Leggett, secretary, treasurer and manager.

BEDFORD.—The People's Electric Light Company has increased its capital stock to $50,000. Mr. Edward Roberts, of Philadelphia, is now president of the company, and Mr. E. E. Mandeville, also of Philadelphia, secretary; Mr. W. S. Pettibone, Cleveland, treasurer; Mr. Stanley Smith, superintendent.

NEW PHILADELPHIA.—The A. Beyer & Leiser Electric Company is now furnishing lighting current to the town of Canal Dover. The officers of the company are as follows: Mr. A. Beyer, president and manager; Mr. W. H. Leiser, secretary; Mr. F. A. Duck, treasurer; Mr. Harry Slasor, superintendent and chief electrician; Mr. A. A. Leiser, chief engineer.

EATON.—The consolidation of the Eaton Light & Artificial Heat Company and the Electric Light,

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Power & Ice Manufacturing Company, which was announced in these columns last month, will be known as the Eaton Public Service Company, which has been incorporated with a capital stock of $200,000. Messrs. C. S. Glass, H. J. Phillips and J. R. Cook are among the incorporators.

CINCINNATI.—Brig.-Gen. Andrew Hinckenlooper, for the past thirty years president of the Cincinnati Gas & Electric Company, died recently at the age of sixty-seven. He rose from captain to brigadier-general in the civil war, and was a famous commander of artillery in the Union army. After the war he was civil engineer of Cincinnati, and from 1880 to 1882 was lieutenant-governor of Ohio.

RICHWOOD.—The electric light plant, formerly owned by Mr. E. A. Schambs, has been consolidated with the Richwood Light, Heat & Power Company under the name of the latter. The new company has a capital stock of $20,000 and the officers are as follows: President, Mr. O. P. Lenox; vice-president, Mr. L. G. Peet; secretary and manager, Mr. L. P. Allbright; treasurer, Mr. B. Cahill; superintendent, Mr. M. Walton.

NEWTON FALLS.—Mr. E. E. Mandeville, of Philadelphia, has been awarded the contract for lighting the village with electricity for a term of ten years, together with a twenty-year franchise for furnishing commercial lighting and power current. According to the terms of the contract, he is to build and equip the plant and furnish 16 arc lights at $70 per lamp, the service to begin within three months.

NORWALK.—The Norwalk Gas & Electric Company has been absorbed by the Cleveland & Southwestern Traction Company, the officers of which are: President, Mr. F. T. Pomery; vice-president, Mr. A. E. Akins; secretary, Mr. E. F. Schneider; treasurer, Mr. E. L. Fuller; all of Cleveland; manager, Mr. H. A. Nichall, Kamms, Ohio; superintendent, Mr. J. A. Nester, Elyria; chief engineer, Mr. E. C. Hundert, Elyria.

COLUMBUS.—Superintendent M. S. Hopkins, of the Columbus Railway & Light Company, recently submitted figures to the City Council relating to the cost of production and distribution of electric current during the year 1903, as shown by the records of the company. The figures included the price paid by the city for street lighting, and when this contract is taken away the average cost of production and distribution per kilowatt-hour will be materially increased. According to the report, the cost of distribution per kilowatt was 2.7 cents and the cost of manufacture 1.243 cents; 10 per cent. depreciation on the actual amount invested represents 2.734 cents a kilowatt, and interest at 5 per cent. was 1.57 cents. The total cost of current furnished over the pole lines only was 7.937 cents a kilowatt, while the average rate received, including street lighting, was 7.27 cents. Mr. Hopkins asked that the price schedule recently fixed by Cincinnati be adopted in Columbus. The Cincinnati ordinance fixes a maximum price of [illegible]1 cents a kilowatt, with a minimum charge of $1 per month. It also provides for a system of discounts based on 16-candlepower lamps or their equivalent, ranging from 5 per cent. on 2000 or 3000 watt-hoursto 40 per cent. on 9000 or over. He said the company is now expending $365,000 in remodeling its machinery and extending its service, and that in a short time there would be no part of the city without light.

OKLAHOMA TERRITORY.

ENID.—The following are the officers of the Enid Electric & Gas Company, which began operations last year on a capital of $200,000. Mr. H. M. Byllesby, of Chicago, president; Mr. J. S. Cummins, Chicago, vice-president; Mr. Robert Graf, Chicago, secretary and treasurer; Mr. T. K. Jackson, this city, chief engineer and electrician.

OREGON.

PORTLAND.—Mr. E. Hippeley is now chief engineer of the Portland General Electric Company.

SPRINGFIELD.—The light and power plant of the Lane County Electric Company at this place is now in operation and will continue to furnish Eugene and adjacent towns with light and power.

PORTLAND.—The Washington Water Power Company, of Portland, is arranging to increase the capacity of its plant five-fold, giving the city plants 70,000 horse-power, at an estimated cost of $1,500,000.

PENDLETON.—The Northwestern Gas & Electric Company, which recently purchased the Pendleton electric light plant, has secured a 25-year gas franchise, and construction work on the new plant will begin shortly.

PORTLAND.—The director of the works at the Lewis and Clark Fair is receiving bids for furnishing electric current for lighting and power purposes on the exposition grounds and in the various buildings.

DALLAS.—Mr. M. D. Ellis, for three years proprietor of the electric light plant, has sold his entire interest in the establishment to Mr. J. G. Van Orsdel. Mr. Van Orsdel, it is said, contemplates extensive alterations to the plant and will put in improvements to the extent of several thousand dollars. Mr. Frederick West has been retained by the new management as chief engineer.

COTTAGE GROVE.—The Cottage Grove Electric Company recently absorbed the Cottage Grove Electric Light Company and is now building extensions to its lines. The following-named gentlemen are the company's officers: Mr. W. M. Sheehy, president and superintendent; M. W. Thompson, vice-president; H. O. Thompson, secretary, treasurer and manager; T. C. Abrams, chief engineer and electrician.

LA GRANDE.—The La Grande Light & Power Company has sold its entire holding to the Thronson Stock & Land Company in consideration of $40,000. The latter company is composed of J. A. Thronson, C. J. Thronson, Thomas Thronson and C. J. Broughton, of Dayton, Wash. Mr. J. Thronson is president and Mr. C. J. Thronson, treasurer. Mr. Fred M. Housh, who for some weeks past has been acting as electrician for the old firm, has been retained by the new management as superintendent and assistant manager. About $16,000 will be expended by the new company in improvements.

PENNSYLVANIA.

GIRARD.—The city now owns its own electric light plant. Charles Eggleston is chief engineer.

TARENTUM.—Mr. J. H. Humphrey is now in charge of the borough lighting plant, as superintendent.

PECKVILLE.—Mr. T. C. Williams is now chief engineer of the municipal lighting plant operated by the Borough of Blakeley.

MILLVALE.—Mr. James Grundy is now superintendent of the municipal water and light plant, and Mr. J. K. Weaver is chief engineer.

MECHANICSBURG.—Bids have been called for by the Council for lighting the city by electricity.

TARENTUM.—It has been voted to issue $37,000 in bonds for improvements to the lighting plant and the streets.

HAWLEY.—The following are the officers of the Hawley Electric Light & Power Company: President, Mr. I. F. Megargle; secretary and manager, Mr. S. Laines; treasurer, Mr. E. L. Schlager.

GALLITZIN.—The Gallitzin Electric Light Company is owned and controlled by the Pennsylvania Coal & Coke Company. Mr. D. P. Conrad is superintendent of the plant.

BLOOMSBURG.—It is the purpose of the Irondale Electric Light, Heat & Power Company, recently incorporated, to furnish electricity to the towns of Catawissa, Rupert and Danville, as well as Bloomsburg.

HANOVER.—A charter has been granted to the Hanover Electric Power & Heating Company, with a capital of $50,000. The company purposes furnishing electric power and steam heat from a centrally located plant.

SHENANDOAH.—The Shenandoah & Mahanoy City Light, Heat & Power Company has been incorporated with a capital of $75,000. Mr. David Graham, of Mahanoy City, is president, and Mr. W. T. Lee, of this city, is president.

MT. PLEASANT.—A charter has been applied for by the Hartigan Electric Light, Heat & Power Company to furnish electricity in this city for light, heat and power purposes. Messrs. John F. Hartigan and J. F. Kalp are among the directors.

CRESSON.—The Cresson Electric Light Company is owned and controlled by the Pennsylvania Coal & Coke Company. The plant is in charge of Mr. D. P. Conrad as superintendent, who is also superintendent of the Gallitzin plant, owned by the same company.

WILMERDING.—The United Electric Company of Wilmerding, organized a couple of months ago, has, on the agreement of the Council to extend the time for putting the proposed plant in operation, placed its order for two 200-h.p. engines and two 150-kw. generators to be installed in the plant upon its completion.

MEADEVILLE.—The following gentlemen have been elected officers of the People's Incandescent Light Company: President and manager, Mr. F. R. Shryock; vice-president, Mr. George D. Traim; secretary, Mr. Cyrus Lee; treasurer, Mr. H. H. Thompson, and chief engineer, Mr. George D. Schreiber.

MAHANOY CITY.—A charter has been applied for by the Economy Light, Heat & Power Company to furnish electricity for light, heat and power in Mahanoy City, Mahanoy Township and Delano Township. Among the incorporators are Mr. Harrison Ball and Mr. John Matthias, of this city; Mr. P. D. Jones, of Hazleton, and F. P. Spiese, of Tamaqua.

RIDLEY PARK.—The Ridley Creek Electrical Supply Company has purchased the John G. Smedley farm in Willistown Township, Chester County, upon which there is a water power of sufficient energy to produce abundant electricity. It is the purpose of the company to furnish light and power to Duffryn Mawr, Paoli, Malvern and other points along the Pennsylvania Railroad.

ELLWOOD CITY.—The Ellwood Power Company, which recently began operations here, is supplying the city lighting plant with current and will establish sub-stations in West Pittsburg and Zelenople, which will necessitate the erection of 24 miles of high-tension transmission line. The officers of the company are: Mr. A. C. Fry, president; Mr. S. A. Rolofs, secretary and treasurer, and Mr. T. K. Bevington, manager and superintendent.

LEBANON.—Mr. Frank C. Wright, superintendent of the Edison Electric Illuminating Company, has been making extensive improvements in line work the past few weeks. The alternating-current line has been extended out Seventh Street to the Iron City Brewery in order to furnish it with power and light; also the shoe factory and the New Lebanon Brewery with light. A line has been run from Seventh Street out Canal Street to Fourth Street for the purpose of supplying twelve new customers who have been secured in the Independent district with lighting current. All of the new machinery at the plant has been installed and is in operation, including two new reserve Edison machines for the commercial lighting of stores, which will obviate the possibility of a break-down. The company has closed two contracts for current for lighting and power purposes, one with the Lebanon Chain Works for which two 30-h.p. three-phase alternating-current motors will be used, and the other for 10 horse-power to be supplied to the new scrap yard. The contract with the Lackawanna Iron & Steel Company for power and lighting current has been renewed for the balance of the year.

SOUTH CAROLINA.

NEWBERRY.—It has been proposed to expend $5000 for improving the electric light plant of the town.

ANDERSON.—A company has been organized in this city to develop the Hatton Shoals on the Tugaloo River. A large electric power plant will be erected.

DARLINGTON.—The officers of the Darlington Light & Water Company are as follows: Mr. W. M. Haynsworth, president and treasurer; Mr. A. G. Haynsworth, secretary; Mr. R. B. Haynsworth, manager, and Mr. C. Hatchel, chief engineer.

ROCK HILL.—The changes in progress at the plant of the Catawba Power Company will shortly

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be completed, when the company will be prepared to furnish current for power purposes during the day. The new machinery is being installed, and the company expects to carry a full stock of electrical appliances and a complete line of motors.

BATESBURG.—An election was recently held to vote on the proposition to bond the town in a sum not exceeding $20,000 for water works, electric lights and general road improvements. The bond issue was carried by a vote of 75 to 18, and the following commissioners were elected to arrange for issuing the bonds, etc.: The Hon. W. H. Timmerman, Mr. L. D. Cullum and Mr. L. B. Kernaghan.

SOUTH DAKOTA.

SPRINGFIELD.—Mr. J. L. Turner is now manager of the Artesian Company of this place.

MITCHELL.—The Electric Company, of this town, expects to make a change in its lighting system from arc to alternating-current series, and will increase the capacity of the plant.

TENNESSEE.

COLUMBIA.—The Columbia Water & Light Company is arranging to add new equipment for supplying a day service.

HUNTINGDON.—Mr. Ernest M. Norman has been re-elected superintendent of the Huntingdon Electric Light & Water Works for the ensuing year.

TRACY CITY.—The Tracy City Electric Light & Power Company has been incorporated, with a capital of $5000, by Samuel and Henry Werner, for the purpose of furnishing electricity for light and heat in this city.

NASHVILLE.—Three of the fifteen lightning arresters at the new power house of the Nashville Railway & Light Company were recently destroyed by lightning. But for these arresters, the damage, which was only $15 or $20, might have amounted to several thousand dollars. The lights were extinguished for about thirty seconds when the bolt struck the power house.

CHATTANOOGA.—The City Council has agreed to a bond issue of $1,000,000 for the purpose of constructing an electric power plant at the Suck, thirteen miles below the city on Tennessee River. The plant will be erected and controlled by private parties, who will pay the city 5 per cent. for the use of the capital to be derived from floating the bonds upon which the city will pay interest. The city reserves the right to purchase the plant at the expiration of fifty years, and during the existence of the contract is given 500 free lights.

TEXAS.

BELTON.—Mr. F. Fairweather is now secretary and manager of the Belton Electric Company.

DE LEON.—Reports state that an electric light plant is to be constructed here by Mr. C. L. Rucker.

LEONARD.—The Electric Light & Ice Company was recently incorporated with a capital stock of $15,000.

SAN ANTONIO.—Bids are wanted by this city for a franchise to construct an electric light, gas and power plant.

COMFORT.—Mr. Max A. Flach is superintendent of the electric light plant here, of which Mr. Ernst Flach is proprietor.

COLUMBUS.—An effort is being made toward the establishment of an electric power plant on the Colorado River at this point.

MATTHEWS CITY.—Articles of incorporation have been filed by the Matthews City Lighting Company, with a capital of $20,000.

NEW BRAUNFELS.—The Landa Electric Light & Power Company expects to rebuild one of its lines at an early date and make other improvements in its system.

BROWNSVILLE.—Judge James B. Wells has been granted a franchise by the City Council for the construction of an electric light plant and water works. He will also establish an electric light plant at Matamoras, Mexico.

EL PASO.—The officers of the International Light & Power Company, which operates plants in this city and Juarez, Mexico, are as follows: President, Mr. Lee Clark; vice-president, Mr. H. T. Edgar; secretary, Mr. John Franklin; treasurer, Mr. A. S. Pratt; superintendent, Mr. Howell Scott, and chief engineer, Mr. John Nelson.

SHERMAN.—The Sherman Gas & Electric Company has been organized in this city, with a capital stock of $200,000, for the purpose of establishing an electric light and power plant. The incorporators of the company are Messrs. J. F. Strickland, W. R. Brents and C. N. Roberts, of Sherman; Mr. R. B. Sticher, of Cleburne, and Messrs. Osie Goodwin, M. B. Templeton and J. L. Penn, of Waxahachie.

EL PASO.—The Mimbres River Water Company recently filed articles of incorporation. The company is capitalized at $2,000,000 and was incorporated for the purpose of carrying on the business of a water company, to build reservoirs and canals to supply water for irrigation, public and private use, and to construct electric light and power plants for domestic and public uses in El Paso and other communities. The incorporators are Messrs. George W. and James S. Delamater, of Pittsburg, Pa.; Mr. Allen G. Kennedy, of Santa Fe, N. M., and Mr. Edward L. Medler, of Albuquerque, N. M. The preliminary arrangements for the construction of large water works to supply this city have been completed. The drafts and plans for the plant and pipe line are being prepared under the direction of Mr. John C. Balcomb. The entire works are to be completed within two years.

UTAH.

LOGAN.—Garff & Sons are negotiating with the City Council to establish and equip an electric light plant, the plant to be sold to the city after four years.

SALT LAKE CITY.—The Pan Power & Electric Company of Utah has been organized in this city, with a capital stock of $10,000. Mr. William D. Cameron is president of the company, and Mr. James A. Mahon, secretary.

OGDEN.—Local reports state that the Utah Light & Railway Company, of Salt Lake City, expects soon to establish a sub-station near the center of this city in order to improve the electric light and power supply service and to prevent the loss of electric energy due to low-voltage transmission. The transformers and other machinery in the company's present plant were recently damaged to the extent of $15,000 by an electrical storm.

SALT LAKE CITY.—The merger of the Consolidated Railway & Power Company, the Utah Company and the Utah Light & Power Company was recently effected and the company incorporated with a capital stock of $10,000,000. The following are its officers: President, Mr. Joseph F. Smith; first vice-president, Mr. John R. Winder; second vice-president, Mr. Joseph S. Wells; treasurer, Mr. Lewis H. Hills; secretary and general manager, Mr. Robert S. Campbell, and assistant secretary, Mr. John M. Whitaker.

VERMONT.

MANCHESTER.—The following are the officers of the Manchester Light & Power Company: President, Mr. John Marsden, Utica, N. Y.; vice-president and treasurer, Mr. George Smith, Manchester; secretary, Mr. A. V. Orvis, Manchester; manager, Mr. A. B. Marsden, Manchester Centre; chief engineer, Mr. Louis Borman.

VIRGINIA.

WEST POINT.—Bids were recently received by the Town Council for the sale of a franchise to light the town by electricity.

TAZEWELL.—Articles of incorporation have been filed by the Tazewell Electric Light & Power Company, indicating a capital stock of $15,000. Mr. Joseph S. Moss is president of the company.

BLACKWOOD.—The necessary current for lighting the town of Blackwood is supplied by the Blackwood Coal & Coke Company. Mr. J. L. Hetler is superintendent of the lighting plant of the company.

HARRISONBURG.—It has been decided by the Council to install a municipal electric light plant which will cost about $70,000. The power for operating the plant will be obtained from the Shenandoah River.

WAYNESBORO.—The Waynesboro Electric Light Company recently purchased a new dynamo and new transformers for its lighting plant, and is increasing its service by the addition of a few short residential lines.

FREDERICKSBURG.—The new purchasers of the water power business here have organized by electing Mr. Joseph Swift, of Wilmington, Del., president, who with New York capitalists and Mr. E. J. Cartwright, of this city, form the directorate. The minimum capital is $50,000, with a maximum of $200,000.

NORFOLK.—In view of the rejection by the Council of the Fentress application for a heating and lighting franchise, the Norfolk Railway & Light Company has announced a reduction of $16\frac{2}{3}$ per cent. to the general public, to the city pumping stations and on any other city lights not included in contracts. The company has also submitted a proposition to enter into an agreement with the Council that the rates for lighting and power be revised at periods of five years hereafter, provided the Council in the meantime will protect the company in its franchises for lighting, the revision of rates to be agreed upon between the Council and the company.

DANVILLE.—The improvements recently made at the municipal electric light plant at a cost of about $9500 have been completed and the entire plant is now in operation. The plant is arranged for both water and steam power, so that whenever the water power becomes inadequate to the requirements the steam machinery can be brought into service. The equipment includes a 300-h.p. engine driving a generator of corresponding size. The addition which was made to the old plant is 22x50 feet and the boiler room is 14x28 feet. The present net income of the plant is about $8000 a year, and it is thought that the amount can be doubled within the next year or so if the council can be induced to string the necessary wires. Superintendent Talbot is making an effort to have this done.

WASHINGTON.

PUYALLUP.—The Puyallup Light & Water Power Company is considering extensive improvements to its system.

BALLARD.—The Ballard Electric Company will shortly begin work on its new plant. A 250-kw. machine has been ordered.

COLFAX.—The Whitman Electric Railway Company is taking preliminary steps toward the installation of an electric power plant.

PORT ANGELES.—The City Council has awarded the contract for erecting a power house for an electric light plant to Rich & Freeman.

BALLARD.—Press reports state that Mr. H. A. Starkey has failed to accept the franchise recently granted him for an electric light plant.

VANCOUVER BARRACKS.—The electric companies have been requested to submit bids for furnishing a complete lighting system to Ft. Wright, Wash.

NOOKSACK.—Recent reports are to the effect that the Washington Mining & Development Company, of Seattle, is arranging for the installation of an electric plant near this city.

NORTH YAKIMA.—The city council has repealed the franchise of the Northwestern Water & Light Company, which was granted to the company last fall for a term of 37 years.

WALLA WALLA.—Mr. Heinrich Hillman is asking the City Council for a franchise for the construction of a street railway and for the purpose of erecting and maintaining a general electric light and power plant.

SNOHOMISH.—The plant of the Electric Light & Power Company has been destroyed by fire, involving a loss of about $6000. A dynamo has been secured and partial service is being provided until the plant can be rebuilt.

MARYSVILLE.—The Marysville Light & Water Company is said to be engaged in the construction of a tunnel from the northwest shore of Lake Stevens in the direction of Marysville. A large

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dam is also being built and the control of the Little Pilchuck has been secured.

WATERVILLE.—The city attorney has been instructed to draw up a contract between the city and George H. Gray & Son to furnish electric power to the city. It is understool that the machinery for the plant has been ordered. Messrs. George H. Gray & Son also operate a plant at Enteat, Wash., of which Mr. G. H. Gray is manager.

PORT TOWNSEND.—Mr. J. M. Kincaid is now chief engineer for the Townsend Gas & Electric Company. Messrs. S. E. Christian and E. D. Sturrock, the former engineers, have started an electrical store under the firm name of the Pacific Electric Company for the purpose of furnishing supplies to the numerous isolated plants in the vicinity of Port Townsend.

WEST VIRGINIA.

WHEELING.—Mr. H. H. Underwood is superintendent of the municipal electric light plant of this city.

MOUNDSVILLE.—The council has granted a franchise to the Moundsville Electric Company. A fifty-year extension was granted, and the company is understood to have the plans ready for a $25,000 plant.

GRAFTON.—Mr. T. P. Kenny, superintendent of the municipal electric plant, states that the equipment consists of one Brush arc generator developing 8500 volts at 500 r.p.m., one Wood arc generator developing 5000 volts at 800 r.p.m., and one Russell engine of 200 horse-power. The plant supplies current for 100 Adams-Bagnall arc lamps and 75 Wood arc lamps.

WHEELING.—The extensive improvements now under way at the plant of the Bellaire Light & Power Company involve an expenditure of nearly $100,000, and will include the installation of a 450-h.p. 4-valve Hamilton-Corliss engine and a 300-kw. G. E. alternator. The capacity of the plant will be nearly doubled, and as the new equipment will make it a duplicate plant the company will be in a position to cope with any emergency that may arise. The present voltage of 1100 will be raised to 2200, and regulators will be installed to insure uniform voltage at all times.

WISCONSIN.

TOMAHAWK.—Mr. V. E. Extrom has been made superintendent of the Electric Light & Telephone Company.

COLUMBUS.—Mr. W. E. Smith is now superintendent and manager of the municipal electric light plant and water works.

LADYSMITH.—The Ladysmith Light & Power Company is arranging for the installation of series arc lights and the development of water power.

WITTENBERG.—It is understood that the contract for an electric light plant to cost about $10,000 has been awarded the Central Construction Company, Oshkosh, Wis.

SUN PRAIRIE.—The Sun Prairie Electric Lighting Company, of which Mr. C. B. Hayden is president, contemplates the construction of twelve miles of transmission line.

BERLIN.—Mr. H. C. Hullinger has been elected president of the Berlin Lighting, Heating & Power Company which has increased its capital stock to $100,000.

MARSHFIELD.—Mr. R. L. Kraus is interested in the formation of a stock company for the purpose of developing electric power from the dam of the Consolidated Water Power & Paper Company.

BERLIN.—The council has called for bids for furnishing and providing on a moonlight schedule 46 arc street lamps for a term of from five to ten years from June 1, 1905, and such additional lamps as the city may require from time to time.

MILWAUKEE.—The City Council is considering the question of issuing bonds to the amount of $150,000 for the construction of a municipal electric light plant. A statement submitted by the City Comptroller showed that it cost the city $256,546.14 to light the streets and public buildings during the year 1903.

NEW RICHMOND.—The Apple River Power Company has begun active work on the construction of a second electric power transmission plant near Somerset. Foundations have just been completed at the present plant for another 300-hp. dynamo, and when the second plant is in operation the company, which now lights New Richmond and pumps the water, will also furnish light and power for Stillwater.

ANTIGO.—The plant of the Antigo Electric Light & Power Company was recently destroyed by fire. The loss on machinery is estimated at $20,000 and the indirect loss will also be large, as the city was without light until arrangements could be made for temporary power and light and many small factories were compelled to shut down for lack of power. All the local newspapers were also put out of business temporarily for the same reason.

WYOMING.

LARAMIE.—The council is considering the matter of installing a municipal electric light plant, and City Clerk David McCullagh writes that the city would like to correspond with parties in regard to the construction of such a plant.

CANADA.

VICTORIA, B. C.—The Elsie Lake Power Company, Ltd., has been incorporated with a capital stock of $10,000.

GRANDIN, SASKATCHEWAN.—The dam on the Saskatchewan River, owned by the Grandin Electric Power Company, was recently washed away.

MITCHELL, ONT.—It is stated that about $10,000 will be expended by the city authorities for improvements to the water works and electric light plant.

RAT PORTAGE, ONT.—The Municipal Electric Light Company, of which Mr. G. L. Mattice is manager, contemplates the erection of a new power station in the near future.

ST. MARYS, ONT.—The Corporation of St. Marys anticipates installing an entire new equipment of machinery in the fall. Mr. T. R. Waugh is superintendent of the plant.

RICHELIEU VILLAGE, QUE.—This village is now furnished with light by the Montreal Light, Heat & Power Company. Mr. J. W. Fleet is superintendent of the local plant.

TRURO, N. S.—The Chambers Electric Light & Power Company has increased its capital stock from $60,000 to $100,000, fully paid in. Mr. S. G. Chambers is president and manager.

The officers of the company are as follows: Mr. W. H. Coleman, of Andover, Mass., president; Mr. L. A. Taylor, secretary, treasurer and manager, and Mr. W. C. Bean, superintendent.

NORTH HATLEY, QUE.—The plant of the Eastern Townships Electric Company is now furnishing lighting current to North Hatley, Waterville, Compton, Lenoxville, Eutis and Capeton.

NANAIMO, B. C.—The Nanaimo Electric Light Company is arranging to harness the waters of the mill stream and will erect a new power house and plant to supersede the present plant. Contracts aggregating $15,000 have been let.

FORT STEELE.—The Elk River Power & Light Company has started work at Elk River Falls and will proceed to install a large power plant immediately. The company expects to furnish power to all the industries in the Crow's Nest Pass.

BRANDON, MAN.—The Western Light & Power Company, with a capital stock of $300,000, has been granted a charter for the purpose of installing an electric plant on the Assiniboine River. Messrs. J. M. Robinson and John Russell, of Brandon, are among the incorporators.

WINNIPEG, MAN.—In a recent report of the city electrician to the Civic Fire, Water and Light Committee, it was suggested that it might be well for the city to consider the building of municipally-owned conduit systems wherein various systems of wires could be carried.

STAYNER, ONT.—Mr. John Knox, proprietor of the electric light plant of this city, states that it is his intention soon to develop water power for the operation of his plant. He also expects to build six miles of transmission line for the transmission of current for lighting and power purposes.

OTTAWA, ONT.—Although the citizens of Ottawa voted two years ago for a municipal lighting system, the City Council recently awarded the contract for lighting the city for a term of ten years to the Ottawa Electric Company. The contract is for $52 per light, which is a reduction of $13 per lamp from the old contract. According to the report of experts the city could do its own lighting for $38 per lamp per year.

MEXICO.

LEON, GUANAJUATO.—Bids have been requested for lighting the city by electricity.

MONTEREY.—The Monterey Light & Power Company expects to expend $150,000 in installing new machinery.

CHIHUAHUA, CHIHUAHUA.—The Compania Industrial Mexicana is making extensions to its present system for power service.

AGUASCALIENTES. — The Aguascalientes Light & Power Company is now lighting the city by means of its two new 50-kw. De Laval turbine-alternators.

VERA CRUZ, VERA CRUZ.—The service of the lighting system in this city is to be increased, for which purpose an order for an additional 500-kw. machine has just been placed.

GUAYNOPITA, CHIHUAHUA.—Mr. J. W. Taylor, of El Paso, Texas, is primarily concerned in a project for the construction of a large electric light and power plant in this city, to be operated by water power.

PUEBLA, PUEBLA.—The City Council has extended the contract of the local electric light and power company for furnishing the city with electric light for a period of twenty-five years on the condition that the capacity of the plant be increased.

YOPIA, DURANGO.—The Mexican Government has received an application from Miguel Morga for a concession permitting him to utilize the waters of the Sobrices River for the operation of a large electric light and power plant which he proposes to build.

JALAPA, VERA CRUZ.—Mr. George Greenwood, for several years superintendent and chief engineer for the Jalapa Railway & Power Company, has been appointed representative of the General Electric Company's interests on the Pacific coast of Mexico.

GUANAJUATO, GUANAJUATO.—A German company has applied to the municipal authorities for a franchise to establish an electric light and power plant in this city. The franchise of the company now supplying the city with electric light and power will expire in August.

MATAMORAS, TAMAULIPAS.—The City Council has granted a franchise to Mr. James B. Wells, of Brownsville, Texas, for the construction of an electric light plant and water works. Contracts are to be let at once for the construction, materials, machinery, etc.

GUADALAJARA.—The contract for the construction and equipment of a water-power plant of 1000 horse-power capacity in this state has just been let. The equipment will include three alternating-current generators of 250-kw. capacity each for direct-connection to water turbines. The transmission line will be about fifteen miles long.

ACAYUCAN, VERA CRUZ.—Mr. Antonio A. Moll is interested in a project by which it is proposed to utilize the waters of the River Ozolonpam, in the southern part of this state, for generating electrical energy to be transmitted to various plantations operated by Americans in that section. It is proposed to use 10,000 liters of water per second.

MEXICO CITY.—Work is progressing on the Necaxa plant of the Mexican Light & Power Company, which is engaged in building the Necaxa-Mexico City-El Oro power transmission system. The plant will have an initial capacity of 45,000 horse-power, with an ultimate capacity for developing 80,000 horse-power. It is expected that contracts for the equipment, etc., will be given out shortly.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

American Electrician.

Vol. XVI. New York, August, 1904. No. 8.

LIGHTING PLANT OF A LARGE OFFICE BUILDING.

THE GENERATING EQUIPMENT OF THE WHITEHALL BUILDING, NEW YORK.

A COMPLETE electric lighting plant in a modern office building is exemplified by that of the new Whitehall Building in New York City. This fire-proof structure occupies the 180-ft. block running from Washington Street to West Street on Battery Place facing Battery Park and New York Harbor, and is 20 stories high with about 8200 square feet of floor space on each floor. The power plant is divided into two parts: one consisting of three 12 x 18½ x 10¼ x 18 pumps which operate the six hydraulic passenger and freight elevators and supply hot water to the whole building; the other consisting of three direct-connected electric units driven by engines having an aggregate capacity of 615 horse-power.

The lighting plant is located in the southeast corner of the basement in a room 32 x 26 feet. The smallest unit is a 75-kw. generator driven by a 125-h.p. engine. The second machine is a 125-kw. generator coupled to a 190-h.p. engine, while the third and largest unit is of 200 kilowatts capacity. All of the generators are 240-volt direct-current compound-wound, engine-type machines built by the Crocker-Wheeler Company, of Ampere, N. J., and the engines to which they are direct-connected were supplied by the Harrisburg Foundry & Machine Works, of Harrisburg, Pa.

In the generators, the magnet frame is a cast iron ring of patented channel section construction, divided horizontally, into which the eight steel poles are cast welded. The field coils are divided into several sections each taped and varnished as a unit, and separated so as to increase the heat radiating facilities. The brush rigging is constructed so that individual adjustment of the brushes is possible. A noticeably large air-gap is left between the pole shoe and the armature with the object of minimizing the field distortion and the unbalancing effect of the armature getting in time slightly out of center with respect to the field.

The three engines are of similar construction. The shaft of each is supported with one bearing on the side of the frame and one on a pedestal supported by an extension of the engine base beyond the generator. It is thus held in positive alignment with the reciprocating parts. The crank-pin, cross head, pin and shoes are enclosed in an oil hood.

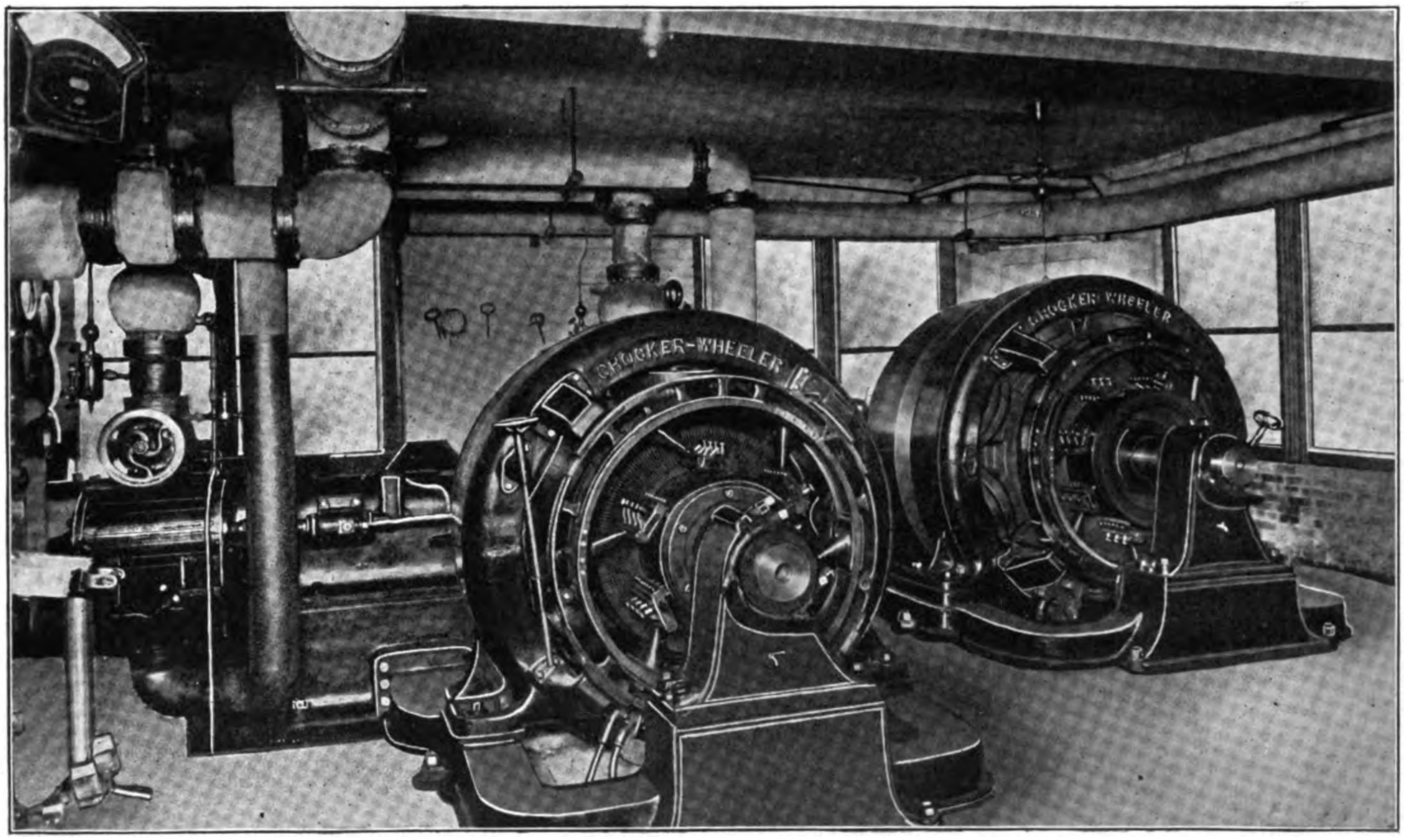

FIG. I.—VIEW OF WHITEHALL BUILDING ENGINE ROOM, SHOWING SMALLER GENERATORS.

Separated from the engine room by a brick wall and some distance away owing to the restrictions of space, is the boiler plant. This consists of three Heine safety water-tube boilers, widely separated, two of which are of 250 horse-power and the other of 210 horse-power capacity. Their normal working pressure is 150 pounds. They are hand stoked and are fitted with improved Treadwell grates. The coal bunkers which extend nearly three-quarters of the length of the building on the north side have a capacity of about 300 tons of rice coal. An elevator to the sidewalk on the Washington Street side lifts the ashes to the street.

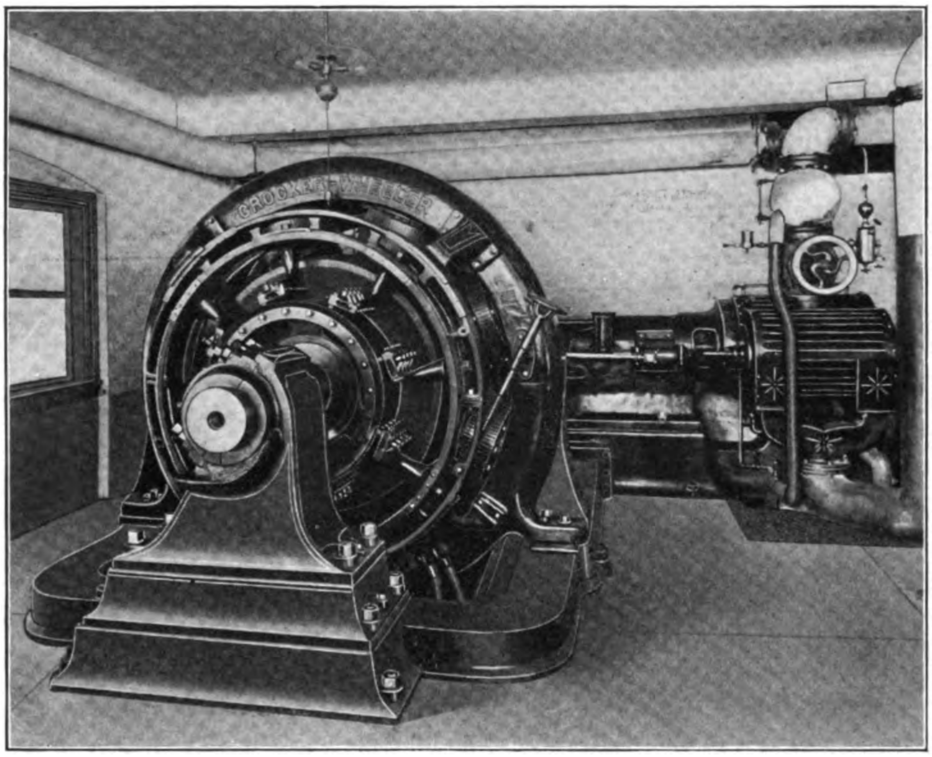
FIG. 2.—LARGE GENERATING UNIT IN WHITEHALL BUILDING.

For supplying steam to the engines there are two main lines of steam piping, asbestos covered, one of which is an auxiliary line which is used only when repairs are being made on the main line. The largest engine takes steam direct from the main 10-in. line through a 7-in. copper bend having a 3-ft. radius. The smaller engines take steam from an auxiliary 7-in. line through 6-in. and 4½-in. copper bends respectively. 8-in., 7-in. and 4½-in. exhaust pipes from the engines connect with a 14-in. main exhaust running to the roof.

Feed-water is supplied through two 7½ x 4½ x 6-in. pumps, but before passing into the boiler it is filtered by a Ward filter of 500 gallons capacity. This is composed of 8 cast iron cylinders 12 inches in diameter and 7 feet over all, and is fitted with special cast zinc bars and filled with animal charcoal. The filter is provided with a removable outside strainer and has a 3-in. feed-water inlet and a 3-in. outlet. It is built for a working pressure of 150 pounds. A 850-h.p. closed feed-water heater of the Berryman type is connected in the feed-water line.

Connected to the main exhaust line is a "Utility" muffler tank 4 ft. 6 in. in diameter and 10 feet long. This contains two separate compartments; one for the exhaust and the other for the high-pressure drips, with an automatic device to control the action of the high-pressure drip pump. A 14-in. inlet and a 14-in. outlet is provided for the exhaust steam. The blow-off tank is 4 ft. by 8 ft. long, and is provided with a cooling coil of seamless brass pipe 3 inches in diameter.

The suctions from the muffler and suction tank are connected to the boiler-feed and house pumps, which are cross-connected in such a manner that either one or more of the pumps can be used to pump water from the main cold water suction tank or the muffler tank and discharge either to the boilers or house tank. The discharge pipes from the boiler feed-pumps are connected to the supply valves on each boiler. All the drips from the engines and pump cylinders and exhaust piping before passing through the muffler tank and oil separator, and the other drips having oil or foreign matter in them are connected to the drip tank through traps. These drips are carried to the drip tank and connected with a check valve on each separate line having different pressures and arranged so that there is no danger of the high-pressure drips interfering with the operation of the low-pressure drips. The drips from the steam separators and any other drips having clean water in them are trapped through high-pressure traps into the muffler tank.

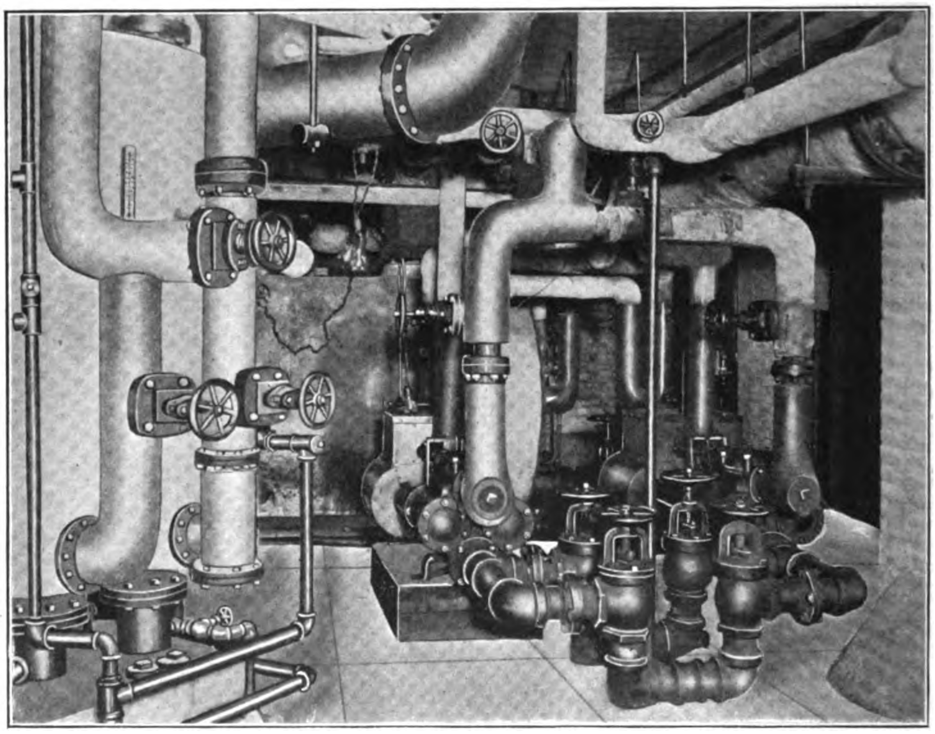
FIG. 3.—FEED WATER PUMPS AND AUXILIARY APPARATUS.

The normal load of the plant is about 100 amperes; but when the days are short this is increased to 700 amperes and has been as heavy as 800 amperes. The switchboard is 7½ feet high by 10 feet wide and consists of five white marble panels. Beginning at the left, the first is a feeder panel with nine switches controlling the lights in the west side of the building, of these three have a capacity of 100 amperes, three of 150 amperes and three of 200 amperes. The second is also a feeder panel for the lights in the east end of the building; the switches being identical with those in the other feeder panel; it is supplied with a Weston voltmeter.

The three remaining and somewhat narrower panels are the generator panels. The first of the three is connected with a 1200-ampere Weston ammeter, a pilot lamp, a voltmeter switch, a Ward Leonard rheostat, an 800-ampere three-pole single-throw switch, and an 800 ampere single-pole I.T.E. circuit-breaker. The next, for the 125-kw. generator, is fitted with a 700-ampere

Weston ammeter, a pilot lamp, a Ward Leonard rheostat, a 600 ampere three-pole single-throw switch, and a 500-ampere single-pole I.T.E. circuit-breaker. The last panel is connected with the smallest generator, of 75-kw. capacity. It is equipped with a 600-ampere Weston ammeter, a pilot lamp, a voltmeter, a Ward Leonard rheostat, a 400-ampere three-pole single-throw switch and a 400-ampere single-pole I.T.E. circuit breaker. Swung on a bracket from the last panel is a Weston station voltmeter. The switchboard is set up four feet from the north wall of the room and access to the rear is had through a grille door at each end.

The current is used almost entirely for lighting. This is done on the two-wire system and over 6000 230-volt incandescent lamps are connected in circuit. The panel boxes in the basement and on the first and second floors are supplied with current from the switchboard through six 100-ampere double-pole single-throw switches and four No. 5, six No. 6 and two No. 8 cables. The distributing panels supplying current from the third to the eighteenth floor are supplied through six 200-ampere double-pole single-throw switches and two No. 0000 cables and two 200,000-cir.-mil cables to the fifth floor; two No. 0000 cables and two 300,000-cir.-mil cables to the tenth floor, and two 300,000-cir.-mil and two 350,000-cir.-mil cables to the fifteenth floor. Sub-feeders to the other floors are of No. 4 cables. Above the eighteenth floor, two 150-ampere switches supply the distributing boxes on the nineteenth floor through two 250,000-cir-mil and two 200,000-cir.-mil cables; sub-feeders to the eighteenth and twentieth floors being of No. 8 cable. All of the cable is, of course, encased in suitable iron conduit.

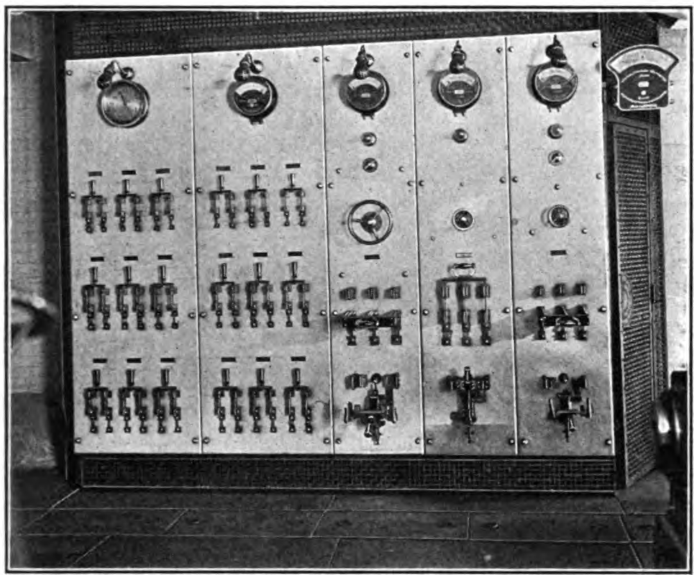

FIG. 4.—SWITCHBOARD.

The entire plant is in charge of Mr. George A. Traver, superintendent. The constructing engineers were the George A. Fuller Company and the steam piping was installed by the New York Steam Fitting Company.

SYNOPSIS OF FUNDAMENTALS PERTAINING TO SPEED VARIATIONS IN DIRECT-CURRENT MOTORS AND DETAILS OF A MOTOR HAVING A WIDE SPEED RANGE

BY ALBERT F. HEMINGWAY.

The elementary quantities regulating the speed of direct-current electric motors are, for the shunt type diagram, Fig. 1, the circuit potential V, volume of field flux N, and the armature surface conductors, W, for the series type V, N, W, and the current I flowing through the motor. The substance of the following relates briefly to the character and limitations in each instance when such quantities are employed to effect speed variations, supplemented with a description of the leading features of a type of motor originated especially with a view to a wide range of speed variation and simple control, in which a serviceable speed range is obtained through a divided magnetic circuit and separated armature portions which operate mutually in effecting the lower speed and differentially effecting the higher.

As the speed of a motor varies proportionately with the circuit potential V, variations in V result in corresponding variations in speed. For instance, if the potential of a circuit upon which a 10-h.p. motor is operating be 200 volts, and if for consideration this potential is diminished 75 per cent to 50 volts, the speed, and still further, the power will be diminished a corresponding amount. If the character of service be such that constant power is required at all periods of the speed range, the horse-power of the motor must be determined according to the lowest speed and potential. If at 50 volts the rating of the motor is to be 10 horse-power, this will increase with the increase of potential and at 200 volts the motor will develop 40 horse-power.

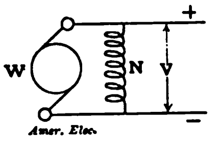

FIG. 1.

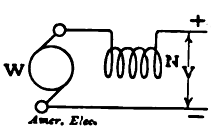

FIG. 2.

In the earlier rheostat method of providing a variable potential through variations in a resistance inserted in the armature circuit, the waste of energy is directly proportional to the diminution of potential; that is, if a 200-volt potential be diminished 75% to 50 volts, the loss is 75%.

A more highly developed and efficient means of obtaining variable potentials is through the use of a number of circuits having a variety of potentials, familiarly known as multi-voltage systems. With two generators three potentials are available; with three generators, six potentials; with four generators, ten potentials; the different motor speeds being obtained by operating the motor on one or another of the circuits.

As the speed of a motor varies inversely with variations in the field flux density N, variations in N result in corresponding variations in speed. As the current flowing through the armature produces a counteracting flux N', which beyond 50 per cent or 75 per cent in its relative value of N creates prohibitive conditions followed by a distortion of the commutating fringe, the region of which is indicated in lines X, Y in Fig. 3, the speed which is varied in this manner has a very limited range without arcing at the commutator, so that manual attendance in adjusting the commutator brushes to coincide with the shifting of the imaginary point X, Y is necessary. If, for example, in a certain motor it is assumed that the ratio of N to N' at the highest speed and maximum load be 1.5, below which arcing at the commutator commences, and that the speed range is to be as 1 to 3, the ratio of N to N' at the lowest speed must then be as 1 to 1.5×3, assuming that the magnet, *i. e.*, the field structure, be tripled in sectional area. The thrice extra flux to be conducted by the armature core requires that its sectional area must also be increased, which, in addition to the increased proportions of the field poles, conjoins to increase both the diameter and length of the armature; consequently each armature turn of wire encircles a greater section of iron. The flux due to the armature ampere-turns increases directly with the section of iron within the coil, and the ratio of N to N' is but slightly increased due to the tripled dimensions; the facts in general being that the iron of the motor increases proportionately with the decrease of speed and the copper as the square of the ratio of variation. For instance, if the speed range be as 1 to 2, four times the

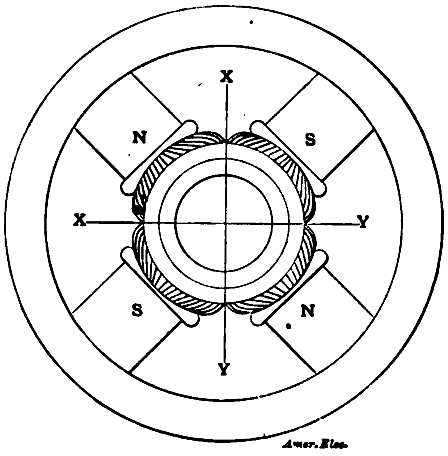

FIG. 3.

copper will be required and twice the iron, compared with a single-speed motor operating at the maximum velocity.

As the speed of a motor varies inversely with the number of armature conductors *W*, any variation in *W* produces corresponding variation in speed. The mechanical difficulties encountered alternating the series and parallel relation of conductors, *W*, to any great extent, upon a revolving armature, are practically insurmountable. Beyond one series and parallel combination through the use of two commutators, intricate and serious difficulties enter which place it out of consideration for the present. By joining two such commutators in series and parallel relation, the speed may be raised as the ratio of 1 to 2.

The series motor so generally employed in connection with the operation of electric railways derives its popularity over the shunt type from its ability to stand abnormal strains and submit to current overloads for short periods of time, the speed of a series motor varying with variations in the circuit potential, field flux and armature surface wires in a similar degree to that of the shunt type. The flexibility in the matter of strains and current over-loads is due in a measure to the fact that in a series motor the speed is sensitively altered with variations in current. In consequence of an excessive flow of current the speed is diminished, and as the power imposed by any given strain comprises the factors, torque and time, through a diminution in speed there is an adjustment of time co-operating with torque or current values. The extra strain, therefore, does not increase the horse-power result (torque × time). In this respect the ordinary shunt motor would prove fundamentally weak if applied in connection with a service of this character, from the fact that its field flux *N* remains constant, while the armature reactive flux *N'* varies with variations in the current passing through it. An abnormal current load thrown upon the armature of a shunt motor produces a magnetic field overpowering in its relation with the field flux; this is a prohibitive condition, resulting in improper commutation. With a series motor, the current that passes through the armature also passes through the field, thus supporting it automatically through all conditions of load and maintaining a fixed relation of armature flux *N'* to the field flux *N*. In consequence of this the position of the commutating brushes does not vary, and within reasonable limits the operation of a series motor does not cause any serious alarm as to arcing at the commutator. The momentary heating would have to be of some duration to realize evil results, but arcing at the commutator, if excessive, would be brief in manifesting its destructive effects.

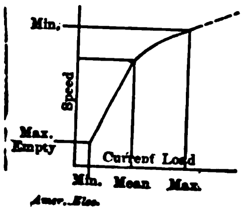

FIG. 4.

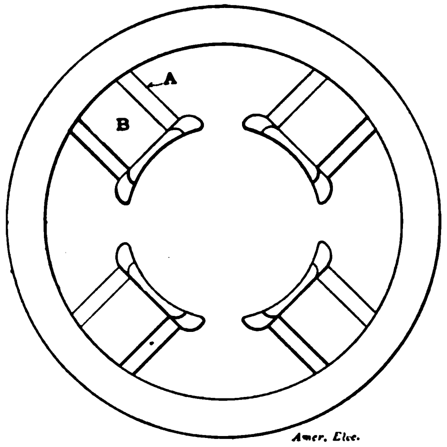

FIG. 5.

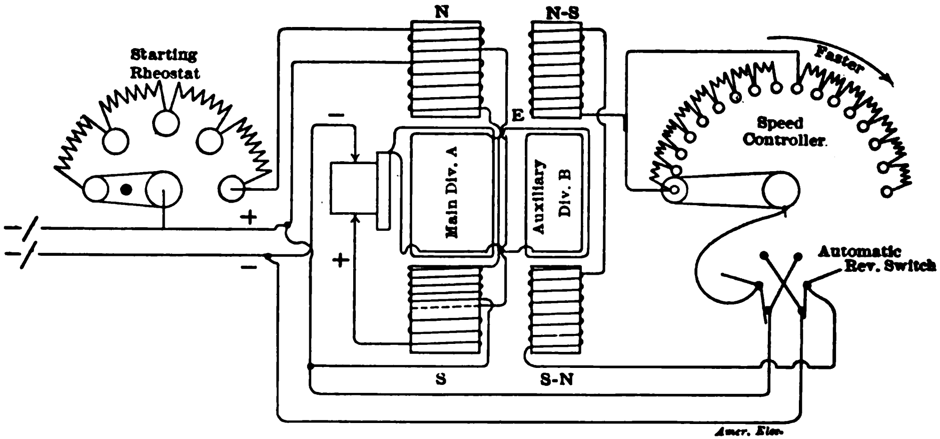

FIG. 6.

The series motor though characteristically suited for operating under abnormal strains, because of the inter-operating relation of armature and field, is entirely incompetent for a service such as driving the majority of factory tools or machines requiring sensitively graduated speeds and effected by current over-loads or sudden strains; the speed of a series motor varying inversely with variations in the current flowing through the armature, reference to which is graphically made by a representation of its saturation curve in Fig. 4. Between the minimum and mean current-load points of the abscissa the greatest variation occurs, while between the mean and maximum load points the speed is approximately uniform, indicating that if this condition of speed is desired the motor should continually operate at or above its mean load point when the iron of the motor is reaching saturation.

In the compound type of motor, which combines both the shunt and series windings, the saturation point *S* referred to is reached and maintained by the shunt winding. It is then evident that a great part of the advantages derived through the use of the series field winding, in respect to submitting to abnormal currents without arcing at the commutator, combines with the inherent speed constancy of the shunt type. The relation of armature flux *N'* to the magnetomotive force, ampere-turns, is kept approximately constant, depending, of course, upon the relation of armature-turns to field series turns.

Whenever speed variations are the result of varying the field density *N* in a compound-wound motor, though the range may be somewhat greater than in the shunt type, speed regulation will be found very poor and erratic. If on the other hand the speed be varied through some agency other than the field flux *N*, as for instance the circuit potential or armature surface conductors, or through the foregoing type of construction, the series winding may become of great assistance, especially when the magnetic circuit is to begin with brought up to saturation by the magnetomotive force of the shunt coils. The then variable magnetomotive force of the series coils serves to balance the relation of armature magnetomotive force to that of the field, and over-loads are possible without serious arcing at the commutator or speed irregularities.

If it were mechanically possible to arrange armature circuits so that various series and multiple combinations of armature surface conductors *W* could be formed upon a revolving armature, it would be, theoretically, an effectual means of obtaining speed variations in a motor operating on a potential of constant value. From the foregoing a constant or fixed potential shunt motor may have its speed varied by varying the field flux *N* or armature conductors *W*, but the inherent incapabilities of the former are quite fully exposed and the latter may be seriously involved with mechanical difficulties. In the form of motor here presented, speed variations are obtained through variations in the seat of counter electromotive force, analogous to variations in conductors *W*, due to the fact that each armature conductor forms part of a circuit a portion of which induces a counter e.m.f. that is variable and capable of being controlled through the field-flux variations of an auxiliary magnet yoke.

By reference to Fig. 5, it will be seen this motor is of the usual multi-polar form. The magnetic field structure is divided, the main division *A* and the auxiliary divisions *B* being indicated by the circuit sketch in Fig. 6. For convenience the description may refer to the armature as possessing but the one winding and core, though as shown in the circuit sketch the armature may possess two distinct divisions, an armature division for each magnetic circuit with a comparatively greater number of surface conductors on the armature of division *B* than there are on that of division *A*, the coils of each armature being connected in series; the coils when joined and completed form virtually but the one armature with more or less surface conductors on one portion than on the other.

As previously mentioned, speed variations are obtained by varying the seat of counter e.m.f. of the armature of division *B*, causing that portion to operate mutually with the main armature *A* in producing the lower speeds and differentially producing the higher, this being accomplished by varying and reversing the field flux of magnetic division *B*, thereby subjecting this armature portion to a variable and controlled counter e.m.f. As the resultant counter e.m.f. of the armature as a whole must remain nearly constant, depending upon the current passing through it, this is accomplished through a compensating adjustment of armature velocity; hence, the true cause of speed variation.

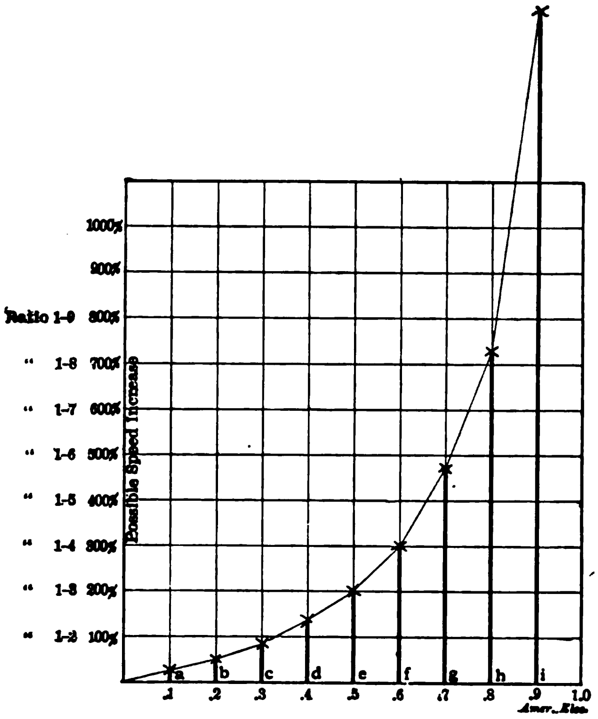

FIG. 7.

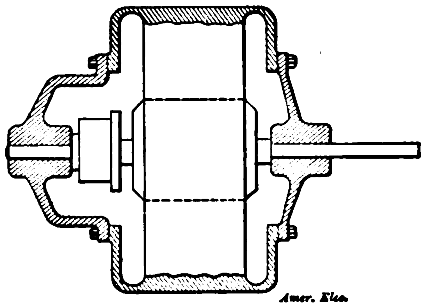

FIG. 8.

In the operation of this motor, the extent of speed range is dependent on the relative strength of division *B* and that of division *A*. If, for illustration, the armature conductors are the same in number for both divisions, and the magnetic circuits, *A* and *B*, are alike in strength, when operated differentially the speed range would become unreasonably great. Referring to the curve shown in Fig. 7, the heavy ordinate lines represent the extent of speed range corresponding with the values of the abscissa directly beneath each line, in terms of relative strength of *A* to *B*. From the curve, it will be seen that where *B* division is .9 in its relative strength of *A*, the line *i* extends upward beyond a reasonable extent, showing the relation of *B* to *A* is too great. At line *h* whence *B* is .8 in its relation to *A*, the possible maximum speed range is eight times the minimum—a ratio of 1 to 8. When *B* is one-half the strength of *A*, the speed range is as 1 to 3. In other words, if the speed when both divisions act mutually be 100 r.p.m., if *B* is .5 in its relation to *A* the maximum speed will reach 300 r.p.m. when the divisions act differentially.

Referring to Fig. 6, division *B* is varied in this manner and reversed and is further comparatively smaller in sectional area. The poles therefore are inclined to embrace the armature at a relatively smaller angle than those of *A*. The weak and erratic condition at times of the magnetism of division *B*, owing to the narrow pole faces, does not spread out far enough to influence the commutating pole tip magnetism of the poles of division *A*, which regulate as in any motor the proper points of setting the commutator brushes. The smaller poles of *B*, therefore, serve appropriately in accomplishing the desired construction.

Referring to Figs. 8 and 9, Fig. 8 is a view to scale of a 5-h.p. four-pole motor, 700 r.p.m., of the usual type, which may have its speed varied in the neighborhood of 15 per cent or 25 per cent by varying the field flux. Fig. 9 is a view also to scale of a motor of the same horse-power output, the difference being that the magnetic circuit and armature are divided and operated as described. Division *B* is .5 in its relative strength to division *A*, and the armature portions have the same relative surface conductors, essentially the one armature. The speed range is 200 per cent, or in the ratio of 1 to 3. The difference in weight and size, as compared with Fig. 8, lies in the extra amount of metal in the enclosing shell and the armature copper and core due to the slight extension in length on account of the space *C*.

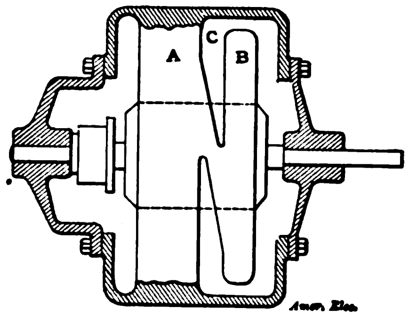

FIG. 9.

Referring to Figs. 10 and 11, Fig. 10 shows a view of a 2½-h.p. motor of 250 r.p.m., having a speed range also of from 15 per cent to 25 per cent by means of field variation. Fig. 11 is a view of the same motor reconstructed to have a speed range of 700 per cent, or a ratio of 1 to 8. The relatively greater size of these motors of small power, compared with those shown in Figs. 8 and 9, is due to the lower initial speed.

The developments and refinements going on in connection with direct-current electric power and generating machinery, chronicled particularly within the past few years, relate in no mean degree to methods of abolishing arcing at the commutator. In many instances a resurrection of old and familiar ideas has been instituted afresh, with a more tangible understanding of the thing itself and its due worth. These methods to a great extent consist of armature magnetism counteracting or balancing coils suitably disposed and determined, requiring no small amount of skill and experimentation. A divided field structure, as described by the foregoing, incorporating an auxiliary magnet-yoke division, through which speed variations are obtained independently of the alteration or variations of the established windings of the main motor division, in the writer's opinion is a more serviceable course to take than to attempt speed modifications through alterations of the primary functions of the motor proper.

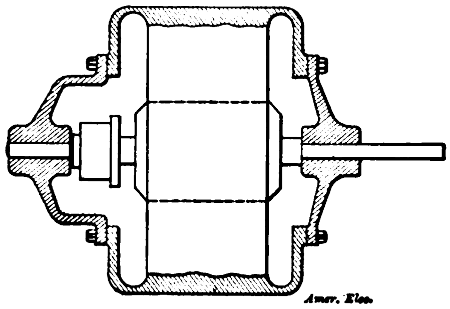

FIG. 10.

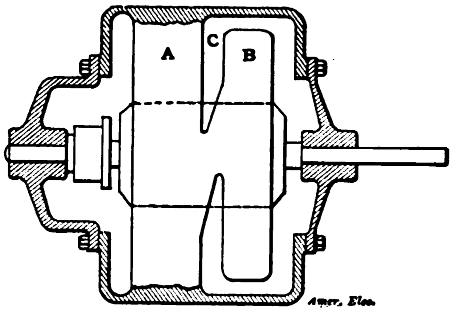

FIG. 11.

ELECTRICAL IRRIGATION.

BY GEORGE E. WALSH.

The extensive irrigation works in operation in the West, or in the process of construction, have given a new appearance to the arid regions, and vast tracts of territory which were formerly of no agricultural value are now producing profitable crops of fruits, grain or vegetables. On the California coast in particular, where the soil and climate are eminently adapted to the growth of grains and fruits, the lack of water was a great drawback, and irrigation has become a feature of the whole industry. The irrigation pumps and machinery employed are of special value because they have been gradually developed to suit existing needs. The early attempts to tap the mountain streams and conduct their waters to the lowlands proved of great commercial value. But in many parts of the Coast this was impossible owing to the great distance between the source of water supply and the farming regions.

Two independent factors have in recent years changed conditions and made it possible to establish large irrigation plants at comparatively little cost. One of these was the discovery that there was sufficient water stored in the underground reservoirs to supply all the fields and farms with the moisture they needed during the dry season. The other was the gradual utilization of the distant mountain streams for electric power generation and the transmission of their power to great distances. Some of the mountain streams furnish power to drive electrical pumps over 100 miles distant, enabling the engineers to utilize the abundant mountain streams in one county to irrigate the fields in another.

In the early part of the present decade the irrigation pumps were driven by windmills and oil engines. The abundant supply of oil found on the Pacific coast seemed to furnish a solution to the problem even without the long-distance electrical transmission. Oil there could be supplied at a cost of 40 or 50 cents a barrel. At this cost for fuel it was possible to make irrigation cheap and successful. Companies were organized on the Pacific coast to drive wells and put up pumping stations. The water was found in the arid regions at depths of 50 to 1000 feet; even the latter depth was not sufficient to discourage the irrigators.

The work of harnessing the streams of the Sierra Madre Mountains made a complete change in the industry. These streams are full at all seasons of the year, and their high falls give ample power in the dry as well as the wet season. They are situated from 50 to 100 miles back from the dry agricultural regions. The original purpose of the pioneers in carrying the electric power from the mountains to the plains below was to supply power to the mills, factories and railways. Los Angeles, 83 miles away, was an excellent market for cheap electric power, and thither the wires were run.

After the power was transmitted successfully the question of finding new customers for it was agitated. Until then no thought had been given to working pumps by electric power; but along the line of the wires a few small pumps were put up. Others quickly followed, and to-day along the line of the long-distance electrical transmission there have sprung up scores and hundreds of irrigating pumps operated by electric motors. There is ample power at all seasons of the year to keep the pumps going, so that dry weather has lost its terror, and farms and fruit orchards have sprung up all along the line.

The electric current, used only when needed, has made irrigation pumping the easiest and cheapest in the world. The farmer needs his power only in emergencies, or during the dry weather; but at such times the need is urgent and imperative. During the rest of the time his pumps are standing idle. The certainty of having power when needed, and in large quantity, is one of the great factors that has made irrigation profitable on the Pacific coast. A single pump such as is used in the Far West irrigates a tract of from 50 to 75 acres, and farms or ranches of any size can easily be supplied.

The driving of the wells in some regions is the most expensive and difficult problem to face. Where the depth is unusual the initial cost of the irrigation outfit is quite serious. On some ranches, however, it has been found perfectly feasible and satisfactory as a money-making investment to sink the wells to the extreme depth of 1000 feet.

Between Los Angeles and the Sierra Madre Mountains, from which the power is drawn, there are upward of 600 electric pumps now in active operation, with scores of others in contemplation. So great is the demand for the power for operating electric irrigation pumps that the engineers have planned greater things for the future. The Kern River, which is some 125 miles from Los Angeles and the great orchard and farming region of the Coast, has been “harnessed.” The power from this river will be distributed over an area of princely value.

Land that had been practically worthless is suddenly brought up to a valuation of nearly $500 per acre, and the proceeds from it pay big interest on the investment at that. The orange and other citrus fruit trees yield abundant crops when grown on irrigated land, while olive orchards and vineyards completely change their appearance and productiveness.

Another field that the projectors of the power development have already invaded is that of pumping oil. California oil fields are in their way almost as important as those of Texas or Pennsylvania. Crude kerosene oil is so abundant on the Pacific coast that it is used as fuel by most of the factories and railroads, and the Oriental line of steamers is also making use of it. The output of the oil is bound to decrease, and the pumping will then become more important. The electric pumps practically reduce the cost and inconvenience, and make even the oil engine pumps less desirable.

The ordinary pumping station for irrigation is simple of construction, and not expensive. Small centrifugal pumps are mostly used for the work, and induction motors are used for driving them. One of the stations supplying a farm of 50 acres or more will require as high as 30 horsepower when in operation, and the pumps will supply from 100 to 22 miner's inches of water. This is sufficient to supply almost any farm or ranch will all the water needed in the dryest of seasons.

The pumps are all housed in wooden buildings, with ditches running to them for conducting the water to the field level. The high tension wires of the electric line are tapped at some convenient place, and carried to the pumping station, where a transformer is used for stepping the voltage down for use by the motor. When the irrigation ditches are filled to suit the needs, the pump is shut down.

The dry season on the California coast extends from May to November, and during this time the pumps are kept in pretty active operation. The fields are never allowed to dry up, for the water is continually flowing over the ground through the ditches and their lateral extensions. Nearly every farm and ranch in this region is practically gridironed by electric wires.

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RAWHIDE IN ENGINEERING.

BY E. N. PERCY.

Rawhide has so many excellent qualities and has been successfully put to so many uses that it is to be regretted that engineers are not better informed regarding it. Being much tougher than leather, also more pliable and soft, it is a superior substitute for that article. It can be compressed by hydraulic pressure into a solid mass which has the toughness of iron and is no more brittle than ordinary rawhide. Rawhide will wear longer under certain conditions than any known substance. When wet it is self-lubricating and almost frictionless.

It is very important for rawhide to be properly cured. If it is not, it decays in damp places, swells, gets soft and loses its strength. On the other hand, if properly cured, it makes the finest of hydraulic packing. Braided to size, much the same as flax is, carefully cured and impregnated with grease, it becomes a fine packing. It costs about five times as much as flax and lasts six or eight times as long. As there are no fibres or fabrics to harden, no rubber to wear out, the rawhide need never be removed, merely more forced into the stuffing box. It is in successful use as water packing on pump pistons, stuffing boxes, hydraulic rams, and in many other places. It does not make a good steam packing because it quickly burns out.

Rawhide gears have attracted favorable attention for a great many years. They are noiseless and require no lubrication. Ordinary gear teeth break at the corners, no matter how broad they may be. This is due to the shock of iron to iron and the imperfect line of contact. Rawhide gears cushion this shock and lend themselves to a more perfect line of contact. As they are made of discs or washers bolted together under great pressure, they cannot break; hence are capable of much higher velocities. The blanks are machined the same as metal and take a high finish.

Belts which slip badly can often be cured by covering the band wheel with rawhide finishing, which gives a very clinging surface. Rawhide gears can be used in many places where metal gears are out of the question and where belts were formerly considered the only possible transmission. One of the most common uses of these gears is in connecting electric motors to triplex pumping plants. Prominent manufacturers use gear transmission with rawhide pinions exclusively. A rawhide belt will far outlast a leather belt. It is softer, more clinging, never hardens, and is much stronger. Round belts are made almost exclusively of rawhide, also bell cord, as it twists better, wears less and is stronger. A round leather belt dries and cracks quickly.

No rope is better suited to the engineer than rawhide. It has no slivers, picks up no filings or glass, grease does not hurt it, and as it is more pliable it is good for blocks, slings, whips, etc. Braided rawhide cord makes excellent grips for tools, levers, hot valves, as well as stout whistle and bell ropes. For belt lacings, rawhide is without a peer. It is as soft as buckskin, much stronger, and is not as dry and grainy as leather. A mallet or hammer for finished metal work made of a block of compressed rawhide is superior in every way to a wooden mallet and it never splits or chips. A rawhide cap over an ordinary hammer makes a tool that is noiseless, also harmless to finished work. Blocks of the material make fine bumpers, fenders and other contrivances that have to receive blows. A steel cap over a pile, protected by a rawhide bumper, has been found to wholly prevent splintering of the pile.

In grooved wheels for rope drive, compressed rawhide has been found to make the best known filling for the grooves; it increases traction and diminishes the wear on the ropes due to slipping. One of the most perplexing automobile troubles has been assisted to a solution by this useful material. The weakness of automobile tires, even the best, is proverbial. If even poor tires are equipped with the stout rawhide tire shoes recently placed on the market, they become almost immune from puncture; in fact, puncture is impossible from anything less than a sharp spike. For use on automobiles, rawhide gears have been found more satisfactory than even forged steel gears, and many of the prominent makes are regularly fitted with them. Their noiselessness is no small inducement.

Aprons of rawhide for mechanics and professional men are very satisfactory because of the strength and softness already mentioned, as compared to the board-like stiffness of the leather apron.

AUTOMATIC BLOCK SIGNALS.

BY RALPH SCOTT.

Some time ago the writer described a number of standard normal danger signal systems, briefly tracing the manner of developing a system which would give every possible protection for a given section of track. The article being short, it was hardly possible to give enough data from which to draw a conclusion or even deduction as to the relative merits of any given system. It is the purpose of the author in this article to take up and show the relative inherent advantages of each standard system as concisely as possible.

For some unknown reason, the attention of electrical engineers has rarely been openly directed to the important field occupied by the automatic railroad signal. On account of the complication of circuits, especially where a number of miles of protected railroad are connected, they are rendered, if the peculiar conditions to be met with on steam railroads be omitted, as much a field for electrical engineers as the storage battery or the synchronous motor.

While it is the purpose of this article to deal with signals from a purely electrical standpoint, a few facts are given to show the relation of electric signals to modern railroad engineering.

The development and perfection of the automatic signal has been very rapid during the last few years. This development has been rather along the lines of simplicity with reliability of indication rather than perfection in mechanical detail. The standard signal of twelve years ago was very different from the one in use to-day.

In Figs. 1 and 2 are shown two views of a signal of that time. This is operated by a weight in a manner similar to that of an old style clock. The controlling mechanism consisted of an electromagnet which obtained its current from a battery connected to the track of the block which the signal protected. The armature of this magnet was so connected to the moving system that when current was not passing through it, the signal arm was at danger. This signal was intended for both day and night indication.

Fig. 1 is a side elevation of the signal mechanism with the signal indicating safety, and Fig. 2 is an elevation which shows the signal at danger. Referring to the illustrations, a semaphore, *b*, gives indications by day, and is directly connected with the moving system *d*; this latter is operated by a weight, not shown, fastened to the chain *n*.

The magnet *m*, through the interposition of the lever *g* controls the movements of *d*. Moving with *b* through the rod *f* is the spectacle *t* which passes before the circular piece of plain glass *a*. *t* serves to give indications by night, a lamp being situated behind it so that the rays are intercepted by this lens. The weight *i* acts against the signal operating weight in such a manner as to control the signal blade movement.

In the lower part of the illustration is shown the means by which the operating weight *i* when it passes to its lower position, holds the signal at danger by opening the circuit at the contacts *u*. The following, which forms one of the claims in the patent covering this signal, will explain, to the reader, the combination.

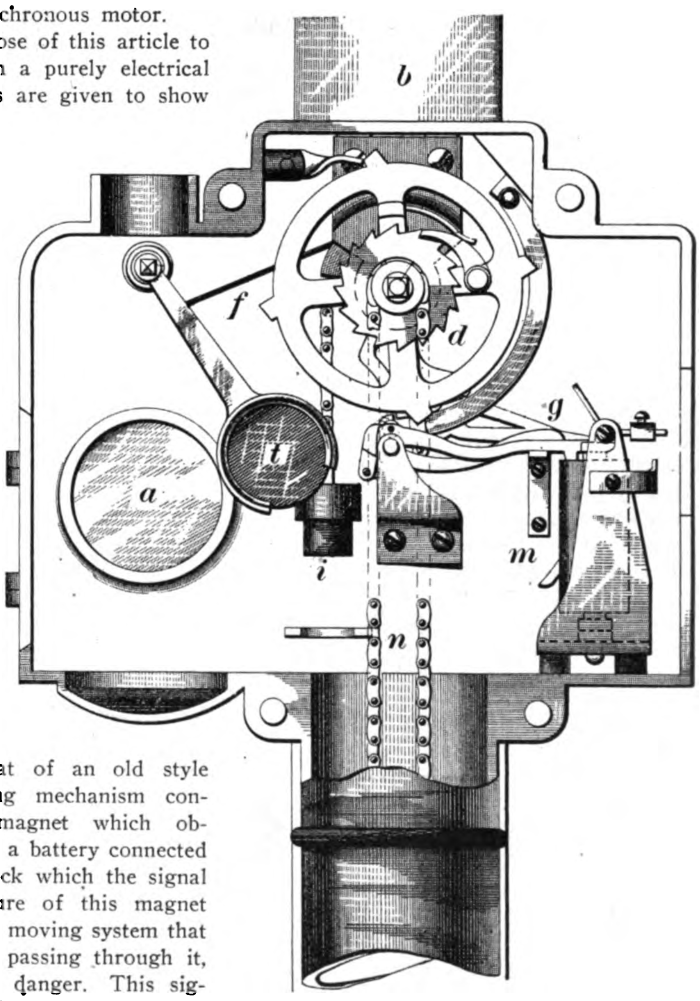

FIG. 1.

"In a semaphore signal, the combination, with a head of two shafts mounted therein, a visual signal blade and a weighted arm secured on one of said shafts, a pivoted latch on one end of said arm, a wheel having projections mounted on the other shafts, means for rotating said shaft and wheel, a curved blade to bear on the pivoted latch, an arm mounted in the bracket, a link connecting the curved blade in the latter arm, a shaft carrying an armature, an electromagnet and an arm on said shaft for holding the trip mechanism, also means for opening the circuit of this magnet when said weight passes to its extreme lower position, thereby setting the signal at danger."

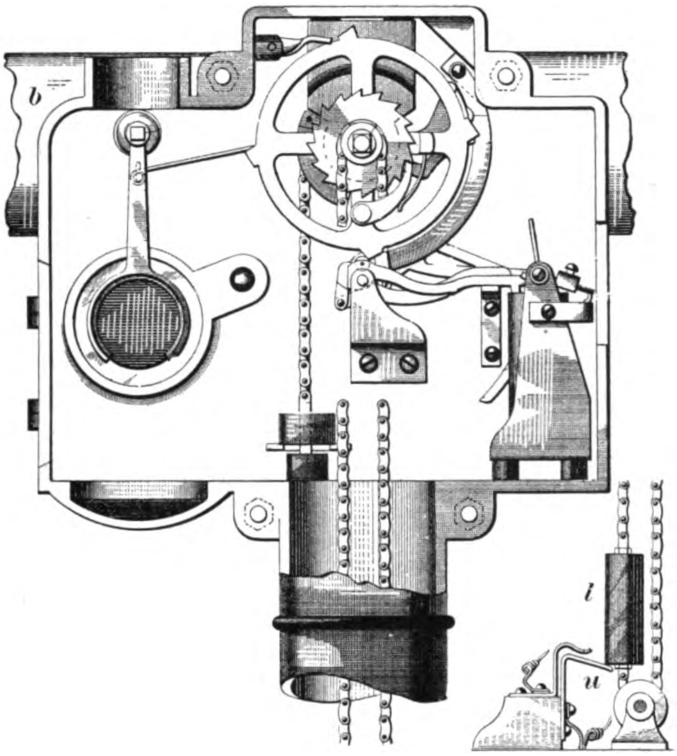

FIG. 2.

The signal used the simple circuit with relay, etc., found in all common signals.

The block signal system is now in use on nearly every American railroad, and in order to show to what extent a representative road is blocked, and the average number of signals per mile, Fig. 3, taken from the *Railroad Gazette* of June 16, 1902, is given. This represents the arrangement of signals on the Philadelphia division of the Pennsylvania Railroad, from Philadelphia to Paoli, a distance of twenty miles. The signals on this section are of the normal clear, electro-pneumatic type.

The electric semaphore signal represents at the present time the highest development in automatic signaling. This is because the semaphore, even at great distances, is much more distinct than any enclosed form of signal. The sleet which in winter covers the glass on the case of the enclosed signal renders a clear view of the banner impossible. This necessitates a stoppage of the train to ascertain the indication, since an obscure signal is always taken as danger.

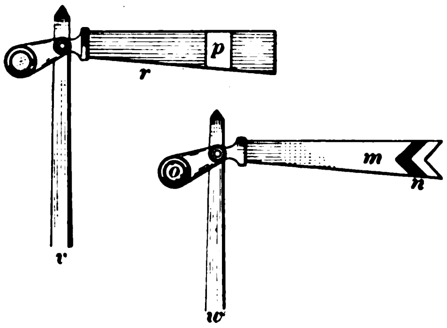

FIG. 4.

The semaphores used are of the same design as those of standard mechanical signals, but means are provided for securing freer motion. The signal arm is moved to the clear position by an electric motor of from 1/8 to 1/6 horsepower, usually located within the base of the signal. The semaphore is generally built to return to the stop position by gravity, the semaphore arm overbalancing the other parts.

The movement of the semaphore is effected in such a positive manner through suitable gearing, that sleet, wind or snow have no effect upon it. The signal, however, is not held in the clear position by the motor, since this would tend to needless waste of energy; but by means of an electro-magnet having high resistance which is permanently connected across the battery terminals as long as it is necessary to hold the signal at clear. Usually these magnets are known as signal slot magnets, and act against gravity by means of a suitable arrangement of levers or cams.

Signal Semaphor Arrangement.

At v and w in Fig. 4 are shown home and distant boards respectively, on separate masts. Each semaphore is used to protect a single block, without reference to the block ahead. This is the practice followed when the blocks are of very great length and are particularly designed for application to single track roads.

The advantage of having home and distant blocks on separate masts is to preclude, as far as possible, the occurrence of the danger condition of a block after the train has passed the home signal. With a very long block such a condition could readily occur. The home semaphore has the form shown at v, the greater part be-

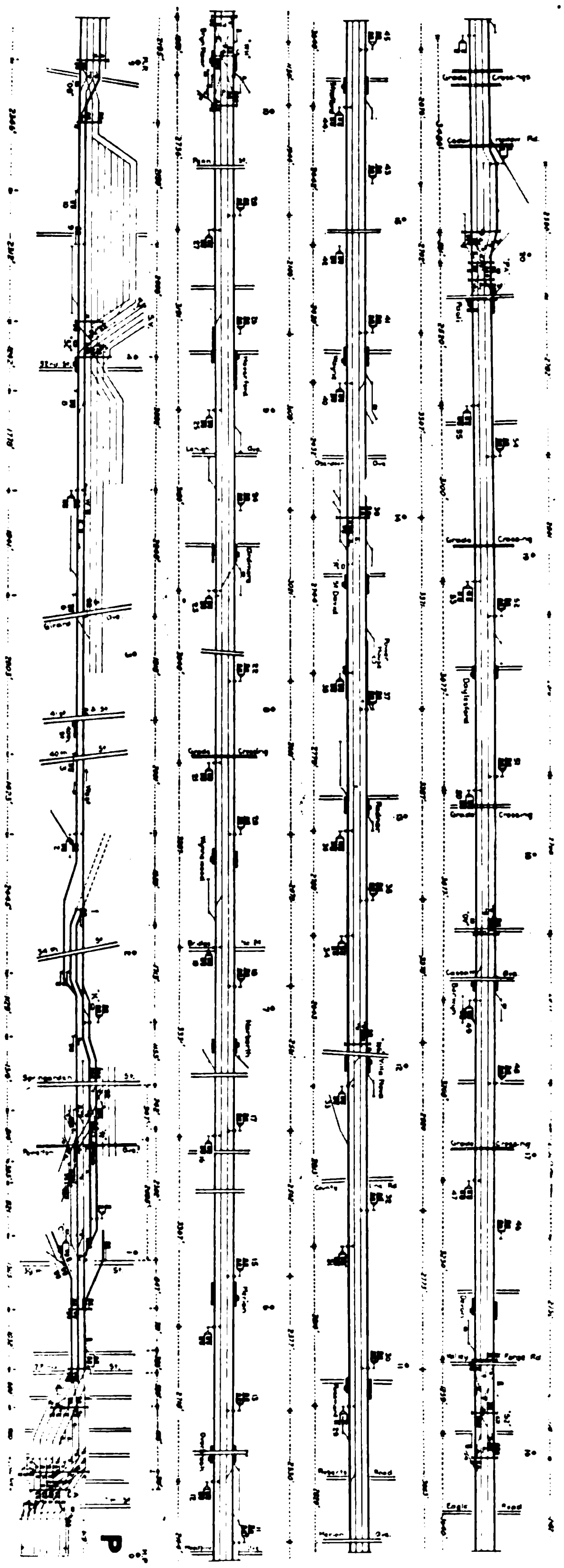

FIG. 3.—BLOCK SIGNAL SYSTEM IN USE ON PHILADELPHIA DIVISION OF THE PENNSYLVANIA RAILROAD.

ing painted red, as shown shaded at *r*, with a small band of white *p*. The distant or fish tail semaphore *w* has a red, yellow or green body *m* with a band of black or white, *n*, parallel with the fish-tailed end.

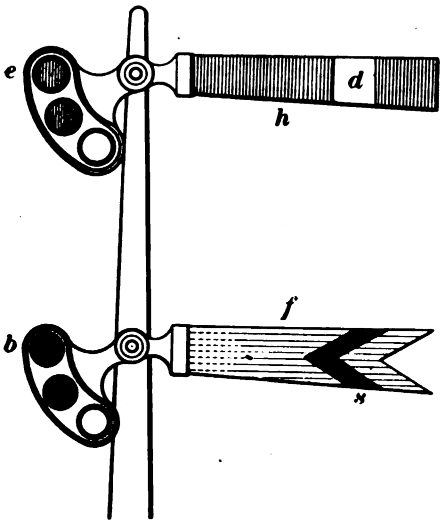

FIG. 5.

The arrangement of a three position signal having home and distant arms on the same masts is shown in Fig. 5, the parts *h*, *d*, *f* and *s* being red, white, yellow and black as in the above. The ends *e* and *b* carry the spectacles, each of these being of a different color, to indicate the relative position of each semaphore. When the arm is 90° from the vertical, danger is indicated, when at 45° caution, and when the position is directly vertical, clear.

This arrangement of indication requires more complicated mechanism than the two positions form, but they are used extensively on a number of trunk lines.

In Fig. 6 three forms of enclosed disc signals, adopted by various roads, are

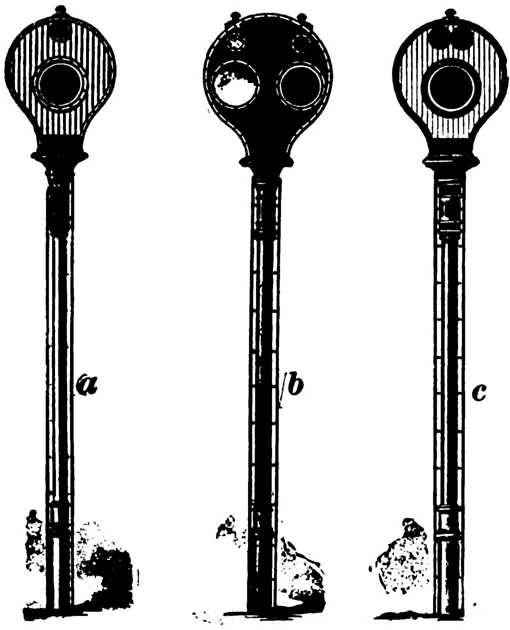

FIG. 6.

shown. *a* is a single block, home and distant signal, *b* a home and distant or two track signal, and *c* a two position signal. Each of these has its special application, but they are not at the present time regarded as standard.

In Fig. 7, a standard semaphore, normal danger, three position motor signal is shown. The batteries are placed within the lower and larger of the cases at the base of the signal mast, the upper case being used for the motor and connections. This signal represents, in form and construction, the result of years of experience in signal development, and it will probably be many years before its outline is radically changed.

Signal Circuits.

In Fig. 8 a simple, normal, clear signal circuit is shown, the two consecutive home signals *H* and *F* having the insulated cut sections 1, 2, 3, 4, 5 and 6. Sections 3, 4 and 5 are in the block protected by *H*, and 1 and 2 in part of the block protected at *F*. Batteries *G* are connected to the farther end of each section, the trains being imagined to move from 6 to 1. The relays *D*, *C*, *A*, *E* and *J* are connected to the opposite end of each section from the respective batteries.

Normally, with no train on either section, the main batteries *R* are discharging current into the signals and, consequently, holding these in the clear position. A train in the block of either section will de-energize one or more of the relays by short circuiting the track batteries, and, by open circuiting the signal battery, hold the signal at danger. The signals in this case are not effected by the movement of a train which approaches either.

In contradistinction to the above, the normal danger signal circuit is shown in Fig 9. As before, two signals are given, these indicating for trains bound in one direction only. Cut sections 7, 8, 9, 10, 11 and 12 are connected respectively to the relays *S*, *V*, *R*, *P* and *Q*. The armatures of the latter are normally held against their contacts, except the lower armature on the relay *R*, which normally breaks the circuit.

The purpose of this latter is to close the circuit of the main signal battery, and, consequently, operate the signal. This will only occur when a train is in a section opposite, and in front of the signal. Hence, when the train is in this section, the signal is moved to the clear position provided all of the other relay armatures in the circuit of the main battery are up, which will not be the case if a train be on either section of the block which the signal protects. Thus, if a train be in section 7 and another train be approaching the second signal, the latter will be held at danger, for the circuit of the signal will be broken at relay *S*.

Hence, a normal danger signal is always at danger, unless a train be approaching it, and then only when everything is in condition to warrant the safe movement after the signal has been passed. In the normal clear system, on the other hand, the signals are always at clear, except when a train is in the block protected by the signal.

A somewhat different and more complicated arrangement of normal danger signal circuits is shown in Fig. 10. This diagram shows the means employed for causing a signal to move to the clear position as soon as the train has reached any part of the block immediately preceding it. Thus, if the lower armatures of either of the relays *M*, *W* and *T* drop, the signal *U* will move to the clear position; that is, if the armatures of the relays *K* and *L* be in the upper position.

This is because the sections 3, 4 and 5 have relays whose lower armatures are connected in multiple, so that if a train be on either section, the signal will move to clear. The same relays have upper armatures, connected in series with the main battery operating the signal *F*. Hence, but a single set of relays is necessary. This diagram, with modifications, represents the usual practice followed in normal danger track circuits on non-polarized line wire systems.

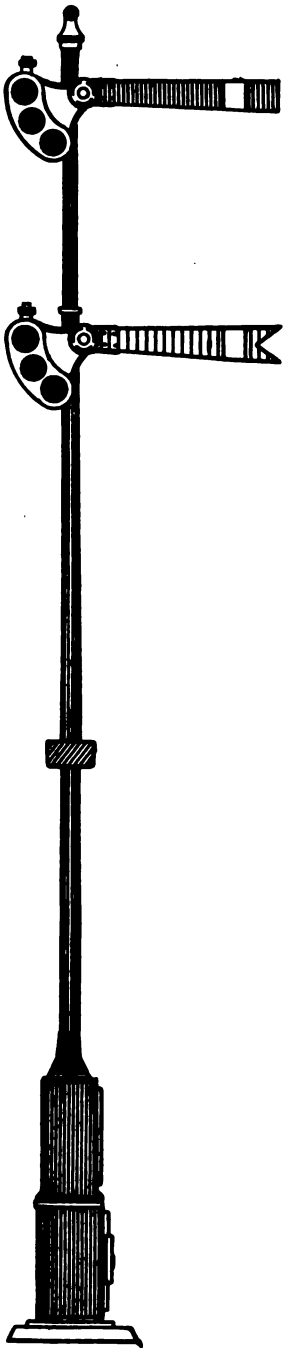

FIG. 7.

The arrangement of the circuits for a home and distant normal clear system on the same masts is shown in Fig. 11. Two signals, *T* and *P*, protecting both home and distant blocks, are operated by means of the relays *O*, *M*, *B*, *W* and *Q*, each having two armatures, the upper of these being connected to the distant, and the lower to the home discs, to the various cut sections.

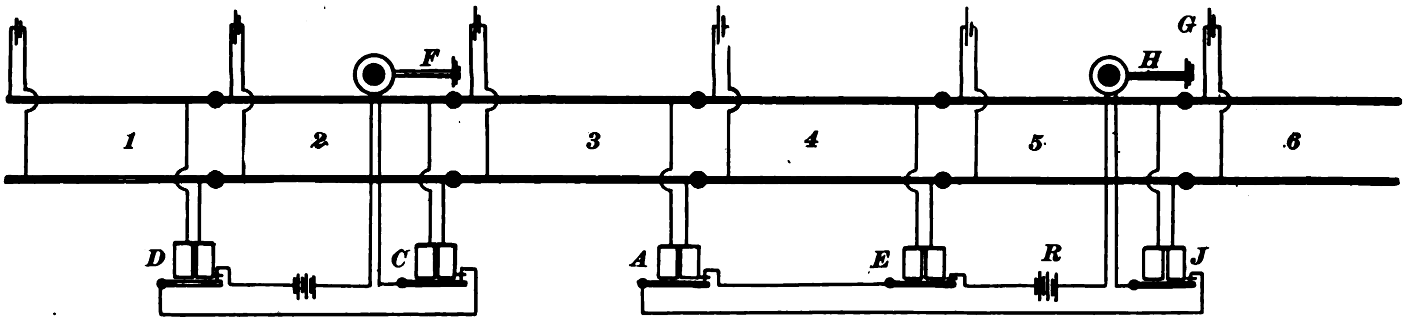
F
G
H
1
2
3
4
5
6
D
C
A
E
R
J

FIG. 8.

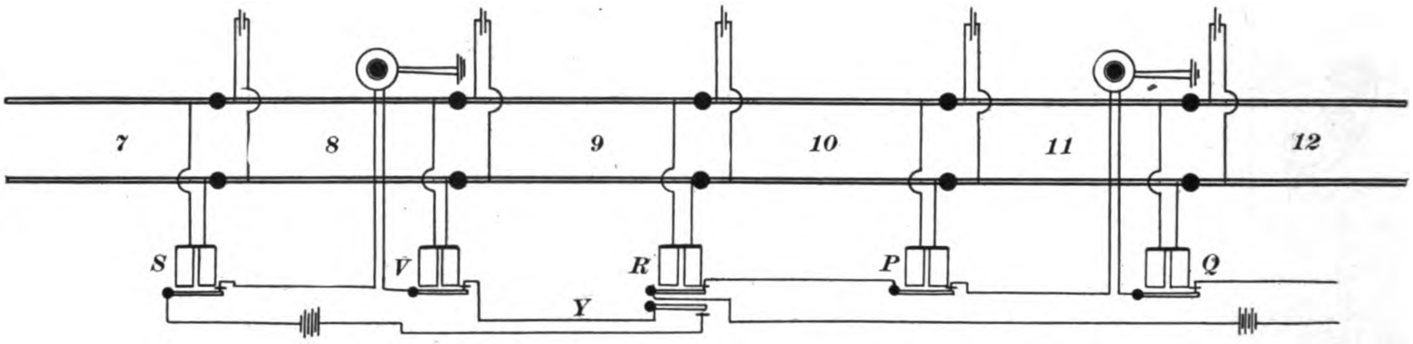
7
8
9
10
11
12
S
V
R
P
Q
Y

FIG. 9.

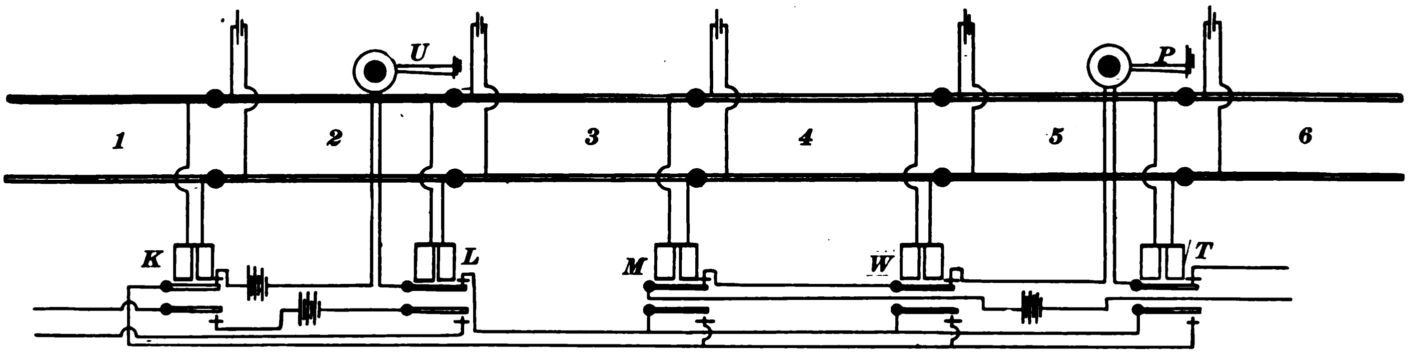
U
P
1
2
3
4
5
6
K
L
M
W
T

FIG. 10.

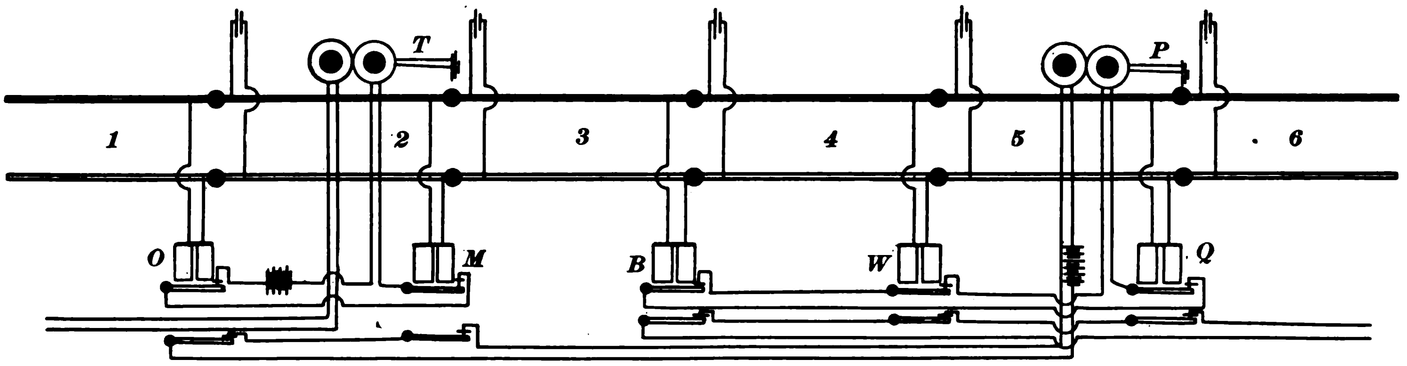
T
P
1
2
3
4
5
6
O
M
B
W
Q

FIG. 11.

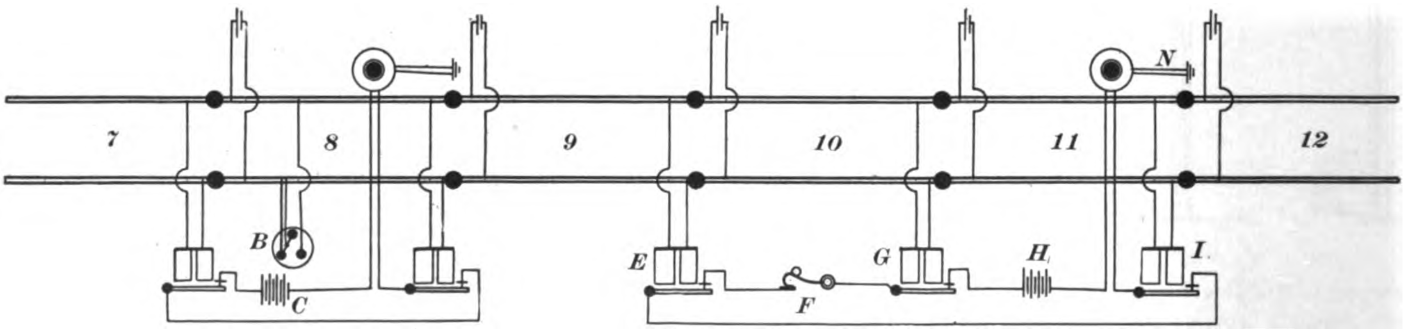
N
7
8
9
10
11
12
B
C
E
F
G
H
I

FIG. 12.

The home disc on *P* is operated by contacts on the armatures of the relays *B*, *W* and *Q*, connected to the sections 3, 4 and 5 and the distant board by the relays *O* and *M* of the sections 1 and 2. Line wires are used in this case to connect the various relays.

The two general means employed for holding a signal at danger when a switch is opened are shown in Fig. 12. Switches are supposed to be located at the sections 8 and 10. A switch instrument at *B* in this case, by the opening of a switch, sets the signal at danger by short circuiting the relay *D*.

This is effected by contacts within the switch instrument which are connected to the tracks by separate wires, and which, through the action of a rotating or moving member, short circuit the track when the switch is opened. The great objection to such a system is the liability of a poor contact or no contact at all to cause a dangerous condition, but not short circuit the relay. Although this condition is of very rare occurrence, it does not represent good signal engineering, as in every signal system, it is not the ***probability*** but the ***absolute certainty*** of the correct action of all apparatus which signifies safety.

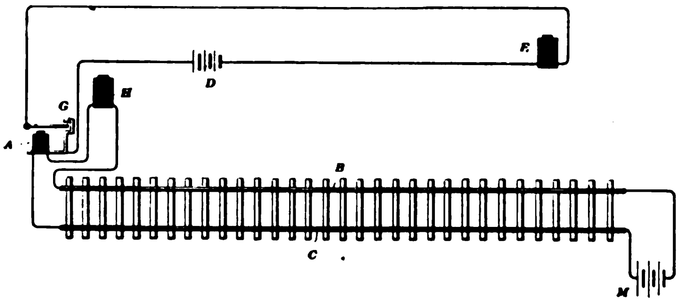

FIG. 13.

At *F* in the illustration another appliance for accomplishing the same purpose in a more reliable manner is shown. The switch instrument at *F* opens the circuit of the signal *N* whenever a switch is opened, even though all the relays *E, G* and *I* be energized.

Although a circuit cannot be closed with any degree of certainty, it may be said that with a low voltage system one can be opened with absolute certainty. The worst that a poor contact can do in this case is to hold the signal at danger. The circuit is closed by means of a roller moving on a spring contact, this roller being moved by the switch through the interposition of suitable connecting means. How this is effected will be shown later.

The normal clear line wire for controlling home and distant boards on separate masts is shown at Fig. 13. The track relay *A* is connected to the rails *B* and *C*, which latter are connected (at the other end of the section) to the batteries *M*. In series with *A* is the magnet *H* which operates the home board.

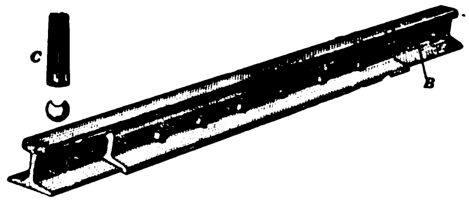

FIG. 14.

When current passes through *H*, as will be the case when the home board is at the clear position, the armature at *A* will make contact with *G*, and thus send current from the battery *D* into the distant magnet *E*. This will not be the case if the line wires are open at any interposed relay. Consequently, when current passes through the home signal magnet the distant signal circuit will also be closed.

It is evident in the track circuits which have been described, that an open circuit in the rails of a section will cause the armature of the relay controlling this section to drop, by depriving this relay of battery current. Hence, on account of the unreliable contact between the fish plates and rails some surer method is necessary to keep the track of each section electrically continuous.

The means for accomplishing this are given in Fig. 14. The bond wire *B* (No. 10 B. W. G. galvanized-iron wire) is connected to the rails, across the fish plates, by channel pins, one of which is shown at *C;* these channel pins being driven with the wire into a hole bored in the web of the rail. The operation of driving home the channel pin makes a contact that can be depended upon.

The bond wire shown is placed beneath the fish plate. This is the usual practice, as it renders the wire inaccessible to mischievous persons. The disadvantage, however, of this method of installation is the fact that the wire is extremely liable to be rusted off, which condition is hard to detect.

The failure of a certain signal thus renders imperative the inspection of all the bond wires in the section where the relay is inoperative. On account of the loss of time incident on such an occurrence, therefore, some railroads place the bond wires outside of the fish plates. In many cases, two wires are used to decrease the factor of the possibility of failure.

BOILER WATER LEVEL INDICATORS.

BY R. T. STROHM.

There are two excellent reasons why the water level in a steam boiler should be readily ascertainable at all times. The first involves the question of safety. There is no fireman who does not feel a greater sense of security in knowing that the upper rows of tubes are well covered, than in suddenly discovering that the only level at which he can draw water from the boiler is at the blow-off. The second reason involves simply the proper working of the boiler. If the water level is maintained at a height greater than that for which the boiler was intended, the steam space will be restricted and priming may occur, especially if the fires are forced.

The water level in a boiler may be determined either by the use of a gauge glass or by the use of try-cocks, while in most cases both fittings are furnished, so that one may corroborate the other. The gauge glass consists of a straight glass tube, connected at one end with the steam space of the boiler and at the other end with the water space. The water then rises to the same level in the glass as in the boiler, and consequently the height of the water is at once apparent to the fireman. Gauge glasses are made with external diameters ranging from ½ in. to 1 in., and from a few inches to 2 ft. in length, depending upon the size and type of boiler to which they are attached. Fig. 1 illustrates a gauge glass as located directly on the shell of the boiler, *A* being the glass, fitted into two angle valves, *B*, B^1, at its ends. These valves are for the purpose of shutting off connection with the boiler in case the glass must be removed, or in case the fires are banked and the boiler allowed to carry steam, under lowered pressure, during the night. The reason for the latter precaution is readily apparent. In many a place where only a day engineer is employed, the fires are banked in the evening so that the plant can be quickly and easily put into operation next morning. If the water glass valves are left open, and the glass should break during the night, the escaping steam may cause much damage to the building and its contents. Actual occurrences of this nature have proven the wisdom of closing the connections to the gauge glass when allowing the boiler to stand idle under steam pressure, in the absence of either engineer or watchman.

The gauge glass is simple and cheap, and furnishes an easy method of determining the level of the water in the boiler. It is open to the objection, however, of being brittle and liable to fracture, either by accidental blows, by sudden chilling due to air or water, by stresses due to expansion and binding in its fittings, or by reason of weakening under the effects of prolonged corrosion. To minimize the breakage by accidental blows, the gauge is protected by rods, *C, C*, parallel to it and at a slight distance from it, held in place by plates attached to the angle valves.

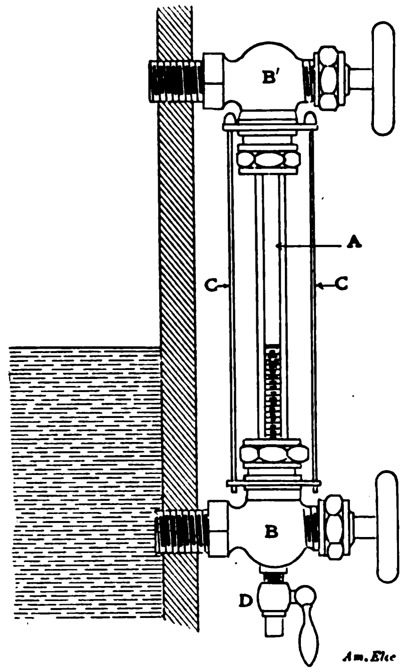

FIG. 1.

The gauge glass most commonly used is that known as the Scotch glass, although there are numerous other makes. These glasses average about three-quarters of an inch in external diameter, and are from one-twelfth to one-seventh of an inch thick. After being drawn and cooled, they must be annealed. For, during the first cooling, the outside chills more quickly than the interior, which sets up internal stresses in the tube. So they are reheated, almost to the melting point, and then allowed to cool very slowly, thus preventing initial stresses.

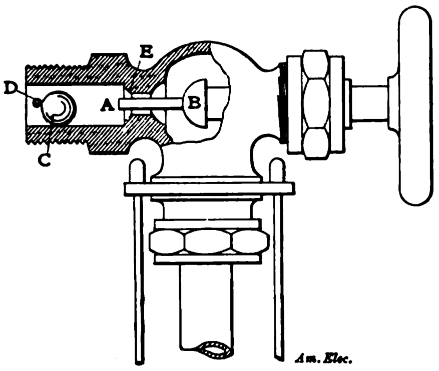

FIG. 2.

Corrosion also effects gauge glasses to a great extent. It not only weakens them, but it frequently discolors the internal surface so as to render it difficult to determine the water level. It is commonly believed that glass is insoluble in water. But in the presence of pure water glass is to a certain degree soluble. The upper end of the glass, in contact with steam, shows this clearly. The steam, condensing, forms drops of distilled water, which is chemically pure, and these drops, trickling down the inner surface of the tube, corrode it. Where soda compounds are used in boilers it has been found that the corrosion proceeds with increased rapidity.

Another objection frequently urged against the gauge glass is that the connections leading to the boiler become clogged with sediment and scale and cause the gauge to give inaccurate and misleading readings. It does not seem quite fair to make an objection of this sort, since any device requires a certain amount of care to maintain it in proper working order, and it is the duty of the fireman to see that the connections are cleaned often enough to prevent inaccurate observations of this nature. It will be noticed that by removing the bonnets of the valves, *B* and B^1, Fig. 1, and taking out the valve stems and discs, straight passages are obtained opposite the nipples leading into the boiler, and so the connections may be easily and quickly cleaned as often as may be necessary. The cock, *D*, is attached for the purpose of blowing out any sediment which may settle in the valve, *B*, as well as for emptying the gauge glass in case it needs to be repacked.

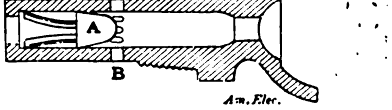

FIG. 3.

In case the gauge glass breaks, and there is no provision for shutting off the escaping steam and water except by closing the valves, *B* and B^1, the fireman has an unpleasant duty before him, and one which promises burns and scalds. To obviate this danger, automatic stop cocks have been invented, one form of which is illustrated by Fig. 2. The figure shows a partial section of the steam end connection of a gauge glass. The stem, *A*, of the valve is continued through the disc, *B*, in the form of a slender rod, which projects through the hole in the valve seat into the nipple leading to the steam space. In this nipple is a metal ball, *C*, somewhat smaller in diameter, which is kept from rolling out into the boiler by means of a pin, *D*. So long as the gauge glass is intact, the ball, *C*, lies against the pin, *D*, the valve stem extension, *A*, being withdrawn out of the opening in the valve seat. Should the gauge glass break, the rush of steam through the nipple will carry the metal ball with it, lodging it against the seat, *E*, where it will be held by the pressure of the steam, thus preventing any further escape of steam from that end of the gauge glass. A similar device at the lower end is used to shut off the water, in case the glass is broken. After the glass has been replaced the valve stem is screwed in, and the rod, *A*, pushes the ball, *C*, back into position against the pin, *D*. In another form of automatic stop, the ball is replaced by a plug of the shape shown at *A*, in Fig. 3, having springs attached to it to keep it in place. The nipple also is lengthened, and the steam or water admitted through the holes, *B*, *B*. The plug is seated by the rush of steam or water which follows the breaking of a glass, and is forced back into place by an extension of the valve stem, as illustrated in Fig. 2.

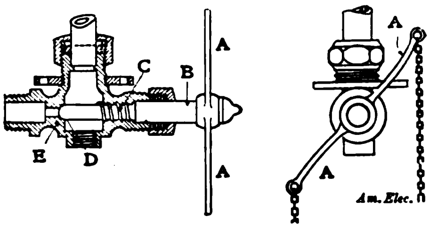

FIG. 4.

A non-automatic device for closing communication with the boiler when the gauge glass breaks is illustrated in Fig. 4. It is simply a quick-closing cock or valve operated from the floor of the boiler room by means of a chain attached to the lever, *A*. The valve stem, *B*, is fitted with a multiple threaded screw, *C*, of large pitch, so that the rotation of the lever, *A*, through about half a turn is sufficient to move the end, *D*, of the stem against the seat, *E*, and close the valve.

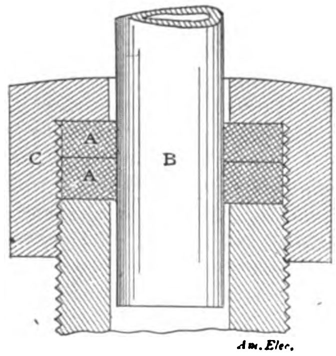

FIG. 5.

In several forms of water-tube boilers in which the water gauge is attached directly to the head of the steam drum, and in vertical boilers, the gauge glass is at a considerable distance from the floor of the boiler room, and it may become difficult to detect the water level if the glass is discolored, or if the lighting of the room is poor. To render the water line easy of determination, glasses are made which show different colors in the water and steam ends of the gauge. In one type, the water shows red, all the steam space showing plain, making it a simple matter to locate the water level. In another, the portion of the glass filled with steam appears silvery white, while the portion filled with water appears black, making the point of division very apparent.

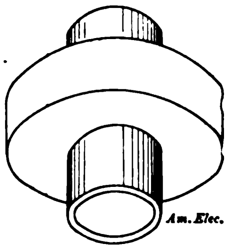

FIG. 6.

The breakage of gauge glasses is very frequently due to binding in the packing at either end. As ordinarily done, the glass is packed as shown by Fig. 5. Two rubber washers, *A*, *A*, are slipped over the end of the glass, *B*, and are compressed by the gland, *C*, so as to form a tight joint. For high pressures, the packing rings must be fairly tight and firm, and they then allow little chance for expansion, while at the same time initial stresses may be set up in the glass itself by screwing down the gland, especially if it is not centered accurately. Accordingly, some engineers have succeeded in obviating this by using a single packing ring, circular in cross-section, in place of the double flat ring shown in the figure. This gives less bearing surface on the glass and permits motion in any direction. Another form of washer which is said to give

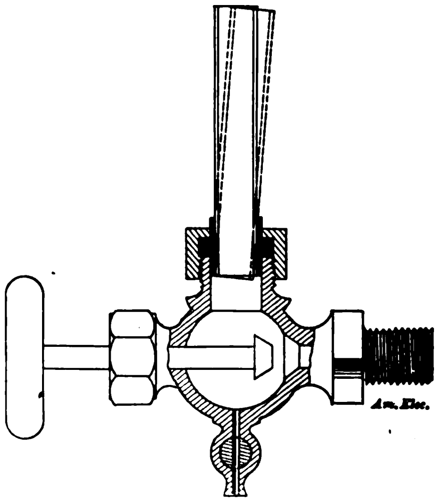

FIG. 7.

excellent results, both in preventing leakage and in preserving the glass from breakage, is illustrated by Fig. 6. The washer is made of rubber and is applied as shown by Fig. 7, forming a flexible joint, yet being perfectly tight by reason of the large surface in contact with the tube.

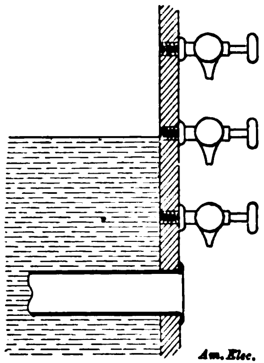

FIG. 8.

While valves between the gauge glass and boiler are advantageous in cases of breakage of the glass, they are regarded as elements of danger by many, as they may be closed, either by responsible or irresponsible persons, and thus give false readings. For example, if the valve, B^1, in Fig. 1 were closed, with the boiler under steam, the steam remaining in the upper end of the glass would some condense, and the water level would rise to the top of the glass, or beyond. If the valve, *B*, were closed, the steam condensing in the steam space of the gauge glass would gradually raise the height of the column.

Consequently, since the gauge glass may, by a variety of causes, give erroneous indications of the water level, it is common to use gauge cocks also, by which to confirm the reading of the glass, or prove its inaccuracy. These gauge cocks are three in number, usually, and are placed one above the other, as illustrated by Fig. 8. The lower one is so located that it is at a distance of about three inches from the top of the upper row of tubes, in boilers of the horizontal tubular class. This distance will vary slightly according to the size of the boiler. The lower gauge cock is thus at the lowest desirable level which the water should attain in actual work. The upper cock is placed at the highest desirable level at which water may be carried, so that the middle cock is at the normal water level. The height of the water may then be easily determined by opening the three gauge cocks in succession. If steam issues when the upper and middle cocks are opened, and water issues upon opening the lower one, it is evident that the water level is somewhere between the middle and the lower cock. The latter is so placed that its center line is at a slightly higher level than the lowest visible point of the gauge glass. Consequently, if there is no sign of water in the glass, and steam alone issues from the lowest gauge cock when it is opened, the water level is dangerously low.

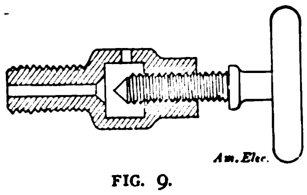

FIG. 9.

One of the most common forms of gauge cock is that shown by Fig. 9. It is simply a body containing a beveled seat into which is screwed a conical plug formed at the end of the stem. The construction is cheap, and the great objection is that the plug always seats in the same position, so that the cock leaks after short service. Repeated grinding, while serving to lengthen the usefulness, eventually destroys the cock entirely. To provide a gauge cock which would be cheap and permit of inexpensive repairs, the type illustrated by Fig. 10 was devised. Instead of a beveled seat, it is made flat. The end of the screw plug is recessed and is filled with babbitt metal. As soon as this babbitt becomes so crushed and worn as to cause a leak, the plug is removed and rebabbitted, thus making the cock as good as new. The seat, being much harder than the metal in the plug, will wear little if any, and it can be faced off whenever necessary, without difficulty.

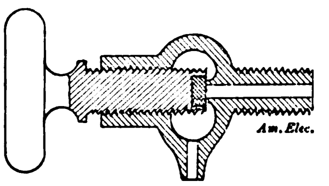

FIG. 10.

The two gauge cocks previously described are slow of action, since they necessitate screwing a stem out and in. A form of quick-opening cock is shown in section by Fig. 11. The body is made hollow, with a beveled seat at the inner end into which fits a disc forming the end of the stem. This stem is somewhat smaller than the hole in the body of the plug and has a sliding fit in the outer end of the plug. The steam or water pressure, acting upon the end of the stem, tends to hold the disc tightly to its seat and prevents leakage when the boiler is under steam. To open the cock the button, *A*, is pressed inward, forcing the disc, *E*, from its seat, allowing steam or water to enter the annular passage, *C*, from which it flows into chamber, *D*, and out at the discharge, *E*. As soon as pressure is removed from *A*, the steam pressure within forces the disc to its seat. This cock, however, is open to the same objection as the two previous ones, since it is liable to close in the same position every time, and eventually leak badly. On the other hand, it may easily be reground.

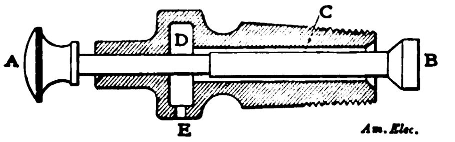

FIG. 11.

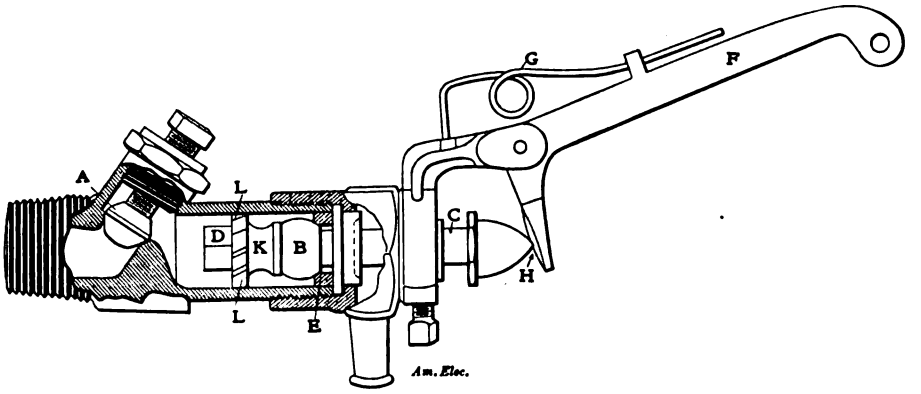

FIG. 13.

A quick-opening diaphragm gauge cock is illustrated by Fig. 12. The cock has a flat seat over which fits a disc, *A*, attached to the diaphragm, *B*. The disc is recessed and filled with rubber or some soft composition metal which will wear much more rapidly than the seat and can be cheaply replaced. The diaphragm is held in place by screwing up the bonnet, *C*, tightly. This bonnet carries a movable stem, *D*, whose head, *E*, presses against the disc, *A*, and keeps the cock closed. The pressure of the stem is due to the helical spring, *F*, which is compressed by the nut, *G*. The cock is opened by pulling downward on a chain or cord attached to the lever, *H*, this motion serving to take the pressure of the spring from the diaphragm. The steam pressure from within will then lift *A* from its seat. The purpose of the diaphragm is to prevent the contact of live steam with the spring, *F*, which might destroy its elasticity. This spring may be set at any desired tension, by adjustment of the nut, *G*, to accommodate it to various boiler pressures.

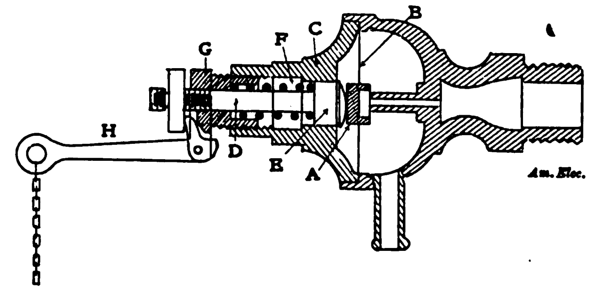

FIG. 12.

The gauge cock shown in Fig. 13 has a number of distinct advantages. In the first place, it is provided with an outside shut-off valve, *A*. In all the other forms it is necessary to remove all pressure from the boiler in order to take out the discs or seats for repair. Or, if this is inconvenient, they must be allowed to leak until the boiler is put out of commission for cleaning or repairs. When the cock in Fig. 13 needs regrinding, the boiler pressure is shut off by closing the valve, *A*. The parts may thus be removed and repaired while the boiler is under steam pressure. The valve, *B*, consists of a bell metal ball held to the stem, *C*, by a nut, *D*. This ball has two faces which are alike, so that if one becomes worn the other may be turned toward the valve seat by simply reversing the position of the ball on the stem. The valve fits close against a seat, *E*, of phosphor bronze. The seat is also made double-ended, and is reversible. Thus the two wearing parts, the valve and the seat, are both able to outlast the ordinary types by reason of their two faces. When in use, the valve, *A*, is opened fully, and the ball, *B*, is held to its seat by the steam pressure. The cock is opened by a downward pull on the lever, *F*, which is returned to its original position by the spring, *G*. The end of the stem is drawn to a point, as at *H*, so that the stem may rotate without being resisted to any great extent by friction against the short arm of the lever. Inside the cock, the stem is fitted with a circular attachment, *K*, on which are vanes, *L*, *L*. The purpose of this is evident. As the steam and water rush out, upon opening the cock, they impinge against the vanes, *L*, *L*, and thus cause the stem to rotate on its axis. This rotation is intended to prevent the seating of the valve in the same relative position after each opening. The wear is thus more evenly distributed and the life of the gauge cock prolonged.

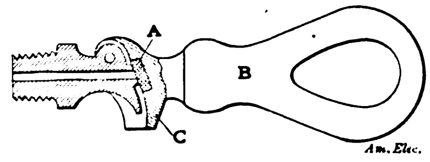

FIG. 14.

Fig. 14 shows a form of try-cock which is to be found on locomotive and portable engines in large numbers. The opening in the valve body is closed by the hard rubber cushion, *A*, set into the handle, *B*, of the cock. This handle is of sufficient weight to keep the valve closed against the pressure in the boiler. The escaping steam and hot water are directed downward by the curved lip, *C*, thus protecting the fireman. This gauge cock is quick-acting, simple, cheap and easy to repair.

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Dangers of Using Kerosene in Boiler Cleaning.—When kerosene or any other innflammable substance has been used in a boiler in any quantity, care should always be taken after opening the boiler up to ventilate it thoroughly before bringing an open light near the manhole.

TELEPHONE ENGINEERING.

Cost of Aerial Cable Lines.

BY F. J. DOMMERQUE.

The cost of aerial cable lines is frequently expressed in dollars per mile. The mile unit is by far too great, as in practice a mile of uniform cable line is hardly ever found. Sometimes the size of the cable changes several times in a mile of pole line; sometimes there is open wire construction on the same line; now and then a cable box is inserted, and so on. To form a reasonably correct idea of the cost of aerial cable lines requires an account of all these variations that may occur. The following suggestions will assist in estimating.

The cost of some of the material, such as cables, messengers, hangers, etc., has already been mentioned. In the following the cost of the cable boxes and balconies will be given and then the cost of labor for stringing the messenger, hanging the cable and other items involved in the construction of aerial cable lines. The cost of the pole line itself, that is, the cost of setting the poles and stringing any open wires if such appear simultaneously upon the same pole line, will be discussed elsewhere, also the cost of anchoring and guying. Pole boxes cost as follows:

Boxes fitted for lightning arresters and tubular fuses:

13-pair cable, not including carbon blocks and fuses, about	$11.00
25-pair cable, not including carbon blocks and fuses, about	16.00
50-pair cable, not including carbon blocks and fuses, about	26.00
100-pair cable, not including carbon blocks and fuses, about	46.00

The carbon blocks and mica arresters cost 3 cents per pair and the tubular fuses 7 cents each.

Boxes fitted with arrester springs only:

13-pair cable, about	$10.00
25-pair cable, about	13.00
50-pair cable, about	22.00
100-pair cable, about	40.00

Boxes fitted for fuses only:

13-pair cable, about	$10.50
25-pair cable, about	14.00
50-pair cable, about	22.50
100-pair cable, about	39.00

Boxes fitted with binding post terminals only:

13-pair cable, about	$8.50
25-pair cable, about	11.00
50-pair cable, about	18.75
100-pair cable, about	33.00

The above prices include a cable end connected up, ready to splice to the main cable.

The cost of iron terminals is about the same as the cost of wooden terminals, except for the very small sizes, the so-called "cans," which are somewhat cheaper. Cans with 10-pair terminals, as used frequently in cable construction in residence districts where party lines are numerous, can be had for as low as $4. Of course, a considerable discount from the above prices may be obtained on large lots.

Pole platforms with galvanized-iron railing and braces cost from $15 to $18, according to size. Pole seats with galvanized back support and braces cost about $5; galvanized-iron pole ring with brace, about $4.50. To put up a box and balcony and connect same will cost about 50 cents per line for labor; this does not include the cost of the wire.

Figuring on the messenger and cable required, an allowance must be made for sag, ends that have to be cut off, splices, potheads, etc. The amount to be added to the messenger should somewhat exceed the amount to be added to the cable, as the messenger has to be wrapped several times around the end poles. Three per cent added to the cable and four per cent to the messenger measurements, taken from the distance between poles, should be sufficient.

The labor involved in stringing the messenger varies according to its size. To string No. 4 steel wire costs about 0.8 cent per foot; to string stranded 5/16-in. messenger costs about 1 cent per foot; to string stranded ⅜-in. messenger costs about 1¼ cents per foot; and to string ½-in. messenger costs about 1⅓ cents per foot. This is for the actual labor spent on the messenger. The actual labor of hanging the cable amounts to about ¾ cent per foot for 10-pair No. 19 B. & S. cable, about 1¼ cents per foot for 25-pair No. 19 B. & S. cable, about 1⅛ cents for 25-pair No. 20 and 50-pair No. 22 B. & S. cable, about ¾ cent per foot for 25-pair No. 22 B. & S. cable, and about 1½ cents per foot for 50-pair Nos. 19 and 20 B. & S. cable.

The above figures do not include the cost of teaming, supervision, watch service, inspection, return of empty reels and incidentals. The amount to be charged to this account is from 50 to 100 per cent. of the cost of the actual or straight labor, according to the distance of hauling, conditions of the road, etc.

The messenger has rarely to be spliced, and when a splice is to be made it does not cost much. The two ends to be spliced are formed into loops, one loop passing through the other, each loop being formed by turning the messenger end back upon itself and clamping it by a strand clamp; the cost, therefore, of an occasional messenger splice may be considered taken care of by the cost of stringing. Not so, however, with cable splices, which occur frequently and are costly. The cost, of course, depends upon the length of the different sections and also upon the location of the splice, whether it is difficult to reach or not. Sometimes a splice has to be made over, because in testing faults in connections or pin holes in the joint are often discovered.

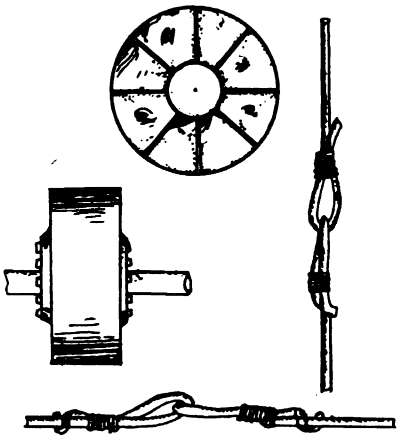
At this juncture attention may be called to a wrinkle in the trade, so to speak. As there are very few splices that do not have to be opened sometime or other, experienced cable men prefer to use for the first making of the splice a sleeve as short as possible and having a rather large diameter, so as to get a short first splice; when the splice is made over a second time they may save cutting in a new piece of cable by using a longer sleeve.

As an approximate figure for the cost of splicing, including also the branch splices to cable boxes, 0.1 cent per foot of 10-pair cable, 0.15 cent per foot of 25-pair cable, and 0.25 cent per foot of 50-pair cable will be about right for average work.

SOME MATERIALS USED BY ELECTRICIANS IN THE PHILIPPINES.

BY OUR MANILA CORRESPONDENT.

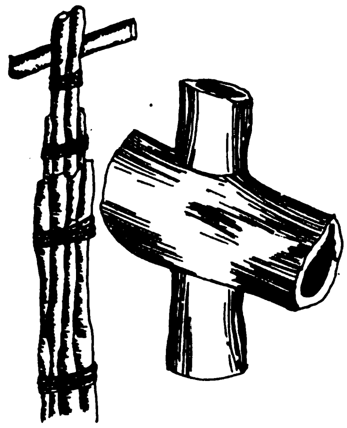
Fig. 1 is a drawing of the sort of wood polishing and smoothing wheels that are used by the native helpers of the electrical corps men of the United States Army in the Philippine Islands. The hardwoods of the booaboey tree are used for this work. Sections are shaped with crude tools and the parts are dovetailed together, producing quite a secure wheel. An edge view is shown in Fig. 2. The sides of the wheels are flanged as shown and these flanges are set-screwed to the shaft on which the wheel is turned. The shaft is turned by means of crank and treadle or by hand-crank device. Fig. 3 illustrates the kind of wiring the natives do if not watched. It is necessary for the American linemen to have native helpers, and these fellows make very odd joints. The unions may hold well enough for a time at least, but the style of connection is not always of a workmanlike order. Ofter the Filipino helper will wrap the ends of the wire over and then bind each as shown with cordage or with finer wire, as shown in Fig. 4; the wrapped ends are further aided in keeping the proper grip by twisting once or twice about the wire.



FIGS. 1, 2, 3 AND 4.

The electrical wire people here usually mark all their packages for transportation by escort wagon or pack train with proper letters. Fig. 5 is a sketching of the sort of stencil used for the purpose. The electrician uses sheet metal, usually brass, and cuts the letter out with a cold chisel. The entire alphabet is made, so that any word can be imprinted upon the packages containing the supplies for the corps.

I should call attention to the odd style of combination bamboo poles which one is obliged to use in this country in certain localities where other stock is not available. Fig. 6 is a drawing of one of these combination poles, consisting of a dozen or two of the slender, elastic bamboo pieces, combined as shown and bound up with wrappings of cord and sometimes wire. This style of pole will stand a great deal of typhoon and earthquake shaking without fracturing. The poles are often bent over by the high winds, but seldom break. They are difficult for the American wiremen to ascend, but are easy for the barefooted, agile native wireman. Cross-arms for poles are often constructed in this service on the rather crude yet effective and practical style shown in Fig. 7. The cross piece is usually cut through and the pole inserted as shown. Seldom are nails or screws used; sometimes wooden pins are driven in to secure the parts. Fig. 8 is a design of native hammer often observed in the belt of the native wireman. The hammer head is shaped from stone or metal and bound to the handle of hardwood with wrappings of split vegetation, thoroughly dried and exceedingly tough. Fig. 9 is one of the inverted cone-shaped stone vessels used in the work. These stone vessels are weighty, but they are lasting and serve many useful purposes.



FIGS. 6 AND 7.

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Gasoline Motor Car Design.

To the Editor American Electrician:

Sir:—I have read with considerable interest the article by Mr. Brocksmith in the July number of the American Electrician and would like to inquire whether or not the car, and especially the engine, was ever built as shown.

I am sure that an indicator card or two from the engine would be extremely interesting to the readers of the American Electrician. There are many automobiles in use to-day with four-cycle, air-cooled engines, but a two-cycle, air-cooled gasoline motor is somewhat of a novelty. While the explosion temperature is lower in the latter type, the average cylinder temperature is usually higher, and it would seem that a long hill in the sun, with the thermometer at 90 degrees, would prove an unsurmountable obstacle to the machine described. Another point not mentioned in the article is the amount of speed regulation possible by means of the throttle. Modern machines can be reduced to one-third of the normal speed by throttle control alone, although of course the output is not maintained.

As the drawing shows chain oilers, it would appear that the engine is lubricated throughout by the crank case oil, but if the oil level is carried at the usual point would not considerable find its way through the transfer passage and be carbonized in the cylinder?

The exhaust port is in the form of a slit, giving a full opening almost instantly, which would tend to make a noisy engine. If the port opened more gradually the burned gases would be discharged with less violence and the area of the indicator card would not be materially reduced.

Information as to the quantity of gasoline consumed per horse-power-hour, under working conditions, would be very acceptable, as the mixture burning capacity figures out seven horse instead of six.

There are several points about the car itself to which attention might be drawn. For instance, the transmission is of the sliding-gear type, the chief advantage of which is a direct drive on the highest speed. In the arrangement shown, however, this is sacrificed, the drive being through a spur gear entailing a loss of ten to fifteen per cent. A transmission not involving this objectionable feature would be equally within the ability of any amateur who could build the engine. The use of gears with 1¼-inch face is highly commendable; one of the least mechanical features at the Automobile Show last winter was the 25-h.p. and 30-h.p. touring cars with transmission gears of ⅞ and 1-inch face. The use of reaches and cross springs has been abandoned by experienced builders.

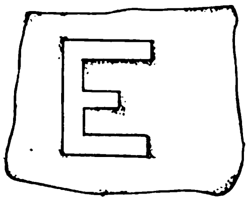
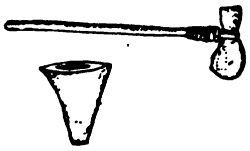


FIG. 5.



FIGS. 8 AND 9.

The clutch shown is very ingenious, but in view of the fact that both male and female members are entirely enclosed, it would seem better to allow the clutch to run in oil and eliminate the leather facing, as the great objection to this form of clutch is its non-slipping quality, always starting the car with more or less of a jerk. The modifications mentioned would allow slipping for several minutes without overheating.

With the arrangement of clutch and brake levers as indicated, the sensation of a rider, if alone, in case his engine stopped while going up hill, may be better imagined than described, although he might carry a large stone along to drop on the brake lever in case such a contingency arose.

The same comment applies to the clutch lever, as it would be impossible to start the engine unless it was depressed. It is quite evident that these levers should be provided with ratchets, and it would be decidedly better if they were interlocked, so that the clutch would be released when the brake lever was depressed.

These remarks are not made in a fault-finding spirit, but I believe if Mr. Brocksmith ever built the car described, an article on its practical operation would be just as interesting as the article on its construction.

New York, July 9. W. F. Hendry.

Replying to Mr. W. F. Hendry's letter I would say that both the engine and the car are entirely original in design; nothing like them has ever been constructed so far as I am aware. It is quite possible, as Mr. Hendry suggests, that the builder of the machine would find some points which required modification; this is true of any new design.

I see no reason why air cooling is not practicable for a two-cycle engine, but if any difficulty were experienced it would be a comparatively easy matter to fit a fan driven from the engine shaft to assist in cooling the cylinders. As to controlling the speed by means of the throttle, two-cycle engines can be very readily controlled in this way, and in fact every marine engine is controlled by throttle.

In regard to oil being thrown into the transfer ports and carbonized in the cylinder, it is possible that this would occur, in which case it would be necessary to put in splash plates similar to the one shown in my gasoline engine design in the January, 1904, number of the American Electrician. This is a small matter and could easily be remedied if any trouble should be experienced.

It is true that in a two-cycle engine the exhaust escapes all at once, and practically the same thing occurs in a four-cycle engine. The muffler is intended to take care of this violent discharge of the burnt gases, and there is no reason why with a good muffler this engine should produce any more exhaust noise than any other engine. On the other hand, there is the absence of cams, gears, valves, etc., which would certainly conduce to quiet running.

I have no figures on the gasoline consumption per horse-power of this or similar engines, but it is probably somewhat greater than it would be in a four-cycle engine on account of the loss of part of the incoming charge with outgoing exhaust. One should be willing, however, to make some sacrifice in economy in order to secure freedom from the complication and noise of four-cycle engines. According to a formula which I have, the horse-power comes out 8 instead of 6; in this connection it may be said that most formulas for computing the developed power of a gasoline engine are merely approximate, as most of them take no account of the compression, condition of mixture, spark advance, etc., all of which have a decided bearing on the output.

The chief advantage of the sliding gear transmission is not that it gives a direct drive on the high speed; this is only obtained in the latest transmission by means of added complication. The advantage lies in the fact that the sliding forms the simplest and most reliable means of obtaining a number of different ratios of transmission within a limited space and weight. The direct drive is impracticable in the present case because the driving shaft must revolve faster than the motor shaft on the high speed in order to keep the size of the low-speed gears within reasonable limits, and also because it would involve extra complication.

The use of reaches and cross spring is still retained on some reputable motor cars, among which may be mentioned the Packard and Crest cars. It is a question whether or not reaches would be actually necessary in the present design, but if they should not be, it would be a most simple matter to omit them without altering the design in the least.

With regard to the clutch and brake pedals it may be said that the brake pedal would probably be improved by the addition of a locking device or ratchet, but this would depend entirely on the locality in which the car was operated.

If it were to be used in Chicago and vicinity it would answer very well just as it stands; whereas if it were to be used in and around Pittsburg, it would probably have to have a ratchet and also two or three extra brakes for use in emergency.

The clutch pedal is never provided with a ratchet and does not require it. If your correspondent will study the drawing of the transmission gear a little more closely he will discover that there is a neutral position of the lever in which there are no gears engaged, this condition occurring between the first forward speed and the reverse. The motor is started with the lever in the neutral position and the clutch pedal must be depressed when it is desired to engage the first speed.

I believe the design on the whole is quite practical and would not hesitate to construct such a car if I had the time and means to do so.

Chicago, July 16. J. C. Brocksmith.

Abstracts from Foreign Contemporaries

Automatic Protective Devices for Electrical Circuits.—The London *Electrician* publishes an account of some interesting demonstrations of various ingenious devices for the protection of electrical circuits given by Mr. L. Andrews. In the closed magnetic device shown by Fig. 1, the series and the shunt windings are so connected up that under normal conditions the fluxes will flow through the field-magnet limbs in series, avoiding the center path through the movable core and air gap. Should the series current become reversed relatively to the shunt current, the fluxes will oppose each other and traverse the center path, corresponding to the armature of a Manchester dynamo, producing a strong field across the air gap and lifting the movable core with considerable force, thus directly releasing the circuit-breaker without the intervention of a relay. One difficulty, however, with a device of this kind, when used with alternating current, is that a further reduction of the shunt current takes place, owing to the inductive action of the series winding in the cut-out device upon the shunt winding. The device illustrated in Fig. 2 appears to overcome this difficulty. It will be seen that the device consists of a transformer wound with two primary and two secondary windings. One of the primaries, usually consisting of one turn, is connected in series with the circuit to be controlled. A current in this winding tends to produce a flux in the center core of the transformer which divides equally between the two magnetic return circuits and cuts the two secondary windings equally. As a consequence the coils of the relay will both be equally energized, and the coil will neither be pulled up nor down. The potential primary winding tends to produce a flux which flows round the outer magnetic circuit, avoiding the center path. This flux will also tend to cut the two secondaries equally. If now the combined effect of the flux, due to the two primaries, is considered, it will be seen that the fluxes in the upper half of the transformer oppose each other, whereas those in the lower half assist each other; as a consequence the core is forcibly held down. These conditions will be maintained so long as the generator supplies current to the bus bars. Should

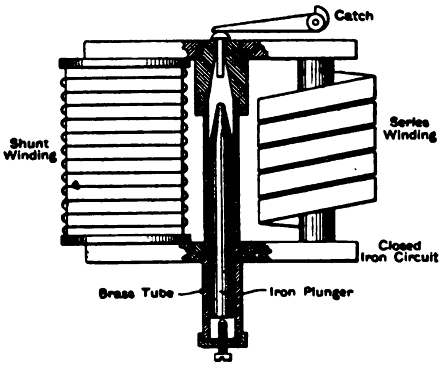


FIG. 1.—CLOSED IRON CIRCUIT RELEASE.

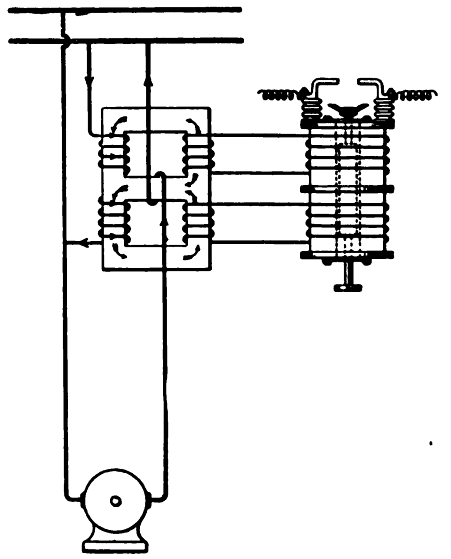


FIG. 2.—DISCRIMINATING RELAY FOR ALTERNATING-CURRENT CUT-OUT.

the direction of the series current become reversed, relatively to the shunt, the fluxes in the lower half of the transformer will oppose each other, and those in the upper half will assist each other, with the result that a much heavier current is induced in the upper secondary than in the lower secondary, and the core is pulled up until it closes the local circuit and operates the cut-out. A method of automatically operating circuit-breakers is shown in Fig. 3. This is an adaptation of a pendulum device *B C D* having a swinging pendulum polarized by a fine wire solenoid, and the free ends of this swinging armature acted upon by two heavy coils carrying the series current. The series winding, *C D*, is in this case connected between the two feeders; as, however, there is normally no difference of potential between these feeders, there will be no tendency for current to flow from one to the other. Should one of the feeders break down, current will flow from the healthy feeder through the series coils of the relay to the faulty feeder, and as this current will have a sense of direction relatively to the shunt winding, *B*, the relay will close the local circuit at *F* or *G*, controlling the circuit breaker, *H J*, on the sub-station end of the faulty feeder. The cross connections shown on the diagram are provided to maintain the choking coil, *A*, non-inductive when one of the feeders has been cut off and the supply continued through the remaining feeder only. A magnetic circuit-breaker with a time element device is shown in Fig. 4.

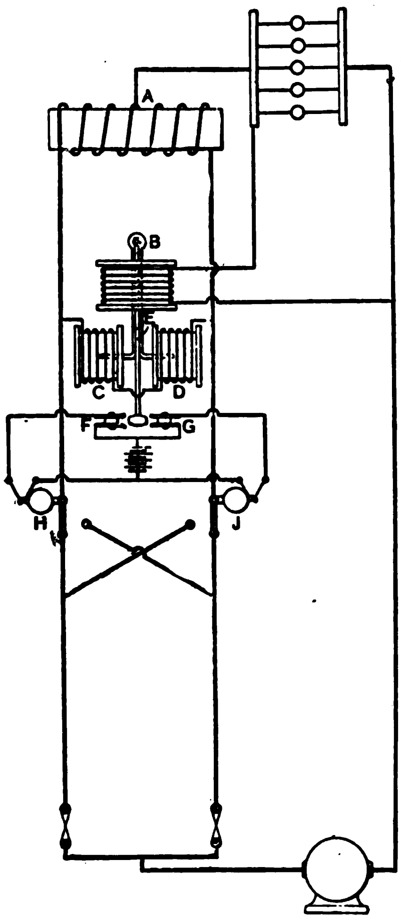


FIG. 3.—DUPLICATE MAINS SWITCH GEAR.

The apparatus consists of a vessel, *A*, containing mercury and some lighter liquid, such as oil; a miniature diving bell directly attached to the operating core is immersed in the mercury. This diving bell is divided into two compartments, *C* and *D*, by a thin diaphragm, and communication is established between the upper and lower compartments through a small hole in this diaphragm. A second hole is also made in the upper portion of the diving bell. It is obvious that a certain current will be required in the solenoid to overcome the weight of the core *B* and diving bell. If the core is lifted slowly the air pressure on the top of the liquid in the diving bell will be equal to the pressure in the outer containing vessel, and as this pressure will be transmitted through the oil to the mercury, the level of the mercury on the inside will equal that on the outside. If, however, the core is lifted more rapidly, the liquid, after passing through the small hole in the diaphragm, is wire-drawn, and, as a consequence, the pressure inside the diving bell will be considerably less than that on the outside, and a column of mercury will be added to the weight of the diving bell, the height of this column depending upon the rate at which the core and diving bell are lifted. If the core is lifted instantaneously none of the light liquid will have time to flow through the diaphragm, and, as a consequence, a vacuum will be produced in the diving bell on the underside of the diaphragm and the whole of the mercury in this will, in consequence, be lifted instantaneously.

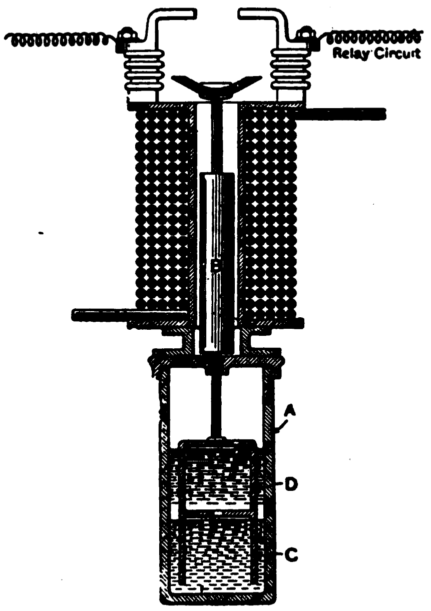


FIG. 4.—TIME LIMIT RELAY.

Verdet and Metais Gas Engines.—Figs. 5 to 9 taken from the *Mechanical Engineer* of London show a design of internal combustion engine, the joint invention of L. Verdet and A. Metais, of Paris. The engine works on the four-stroke cycle and exerts two driving impulses during each revolution of the fly-wheel. Referring to the illustrations Fig. 5 is a longitudinal section and Fig. 6 is a sectional plan of the engine. Fig. 7 is a cross-section through the cylinders, showing the inlet and exhaust valves for the gases. Fig. 8 indicates the operating mechanism of the exhaust valve and Fig. 9 indicates the mechanism of the inlet valves for air and gas. The motor is symmetrical with regard to its axis, *M* M_1. Two connecting rods, *I* and I_1, connect the crank shaft, *G*, with the two main pistons, *D*, by means of two auxiliary pistons, G_2, and two cylindrical rods, *H*, which each extend through stuffing boxes. Each set of parts comprises three chambers, viz., *A B C* on one side and A_1 B_1 C_1 on the other side. *A* and A_1 are the explosion chambers, and are provided with inlet valves, A_2, A_3, respectively for

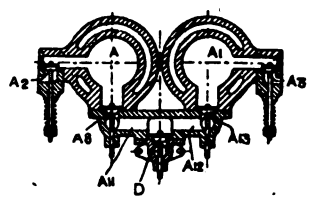


FIG. 7.

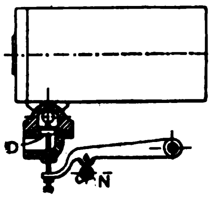


FIG. 8.

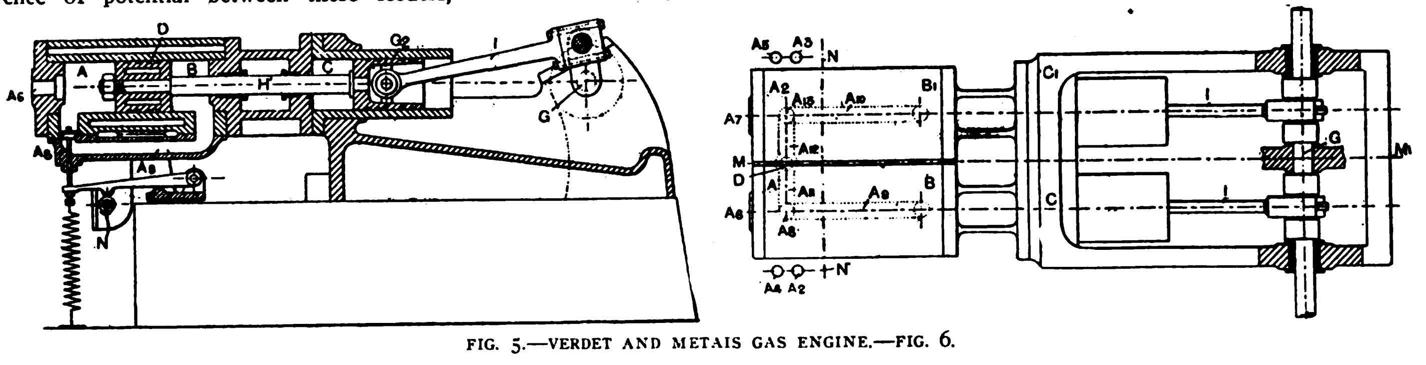


FIG. 5.—VERDET AND METAIS GAS ENGINE.—FIG. 6.

gas, and inlet valves A_4, A_5, respectively for air, and an igniter arranged at A_6 and A_7 respectively. B and B_1 are the expansion chambers, and C and C_1 the strain regulating chambers. D is the main exhaust valve. N is the half-speed shaft carrying the cams for operating the valves, these being all operated automatically by the half-speed shaft. The operation is as follows: The explosions in the chambers, A and A_1, are alternate, each being separated by a revolution of the fly-wheel; for instance, assuming an explosion in chamber A, the pistons move toward the right and at the same time the crank shaft receives a driving impulse. As soon as the pistons arrive at the end of their stroke the valve, A_8, is opened, and establishes communication through the ports, A_9, A_{10}, A_{11}, A_{12}, between the chamber, A, and the expansion chambers, B B_1. The gases thus expand in the chambers, B B_1, and act on the front surfaces of both pistons during the whole return stroke of the pistons. At the end of the return stroke the exhaust valve, D, is opened, and the gases escape into the atmosphere at a pressure much nearer to the atmospheric pressure than if they had beeen exhausted 180° sooner. The explosion then takes place in the chamber, A_1, the pistons again move toward the right, and at the end of the stroke the valve, A_{18}, is opened, and establishes communication between the chamber, A_1, and the chambers, B and B_1. The gases expand during the return stroke, and are then exhausted into the atmosphere, and so on. There is, therefore, an explosion of the contents of one cyqlinder during the stroke of the pistons from left to right, and an expansion in both cylinders during the stroke of the pistons from right to left. The first driving impulse (explosion) being, however, much greater than the second (expansion) the equilibrium is approximately re-established by means of the following arrangement: During the stroke of the pistons from left to right the pistons, G_2, move equally and produce vacua behind them, therefore they diminish the impulse due to the explosion; during the return stroke, on the contrary, the atmospheric pressure working on these pistons is added to the impulse due to expansion.

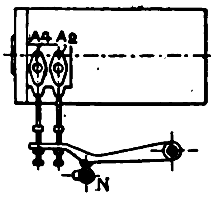


FIG. 9.

Parsons and Stoney's Direct-Current Generator.—The London *Mechanical Engineer* describes in a recent issue the direct-current generator devised by C. A. Parsons and G. C. Stoney, who claim several novel features; chief among which are a practically fixed line of commutation at all loads without sparking and an increase in the allowable ampere turns per inch diameter of the armature. Referring to the illustrations, A A are the field magnets wound with divided shunt coils, B B. The pole pieces, C C, are divided along the line X X. The fixed series winding is placed around the space, D, in which the armature revolves. The winding consists of two coils in series with the armature, the form of winding being that of

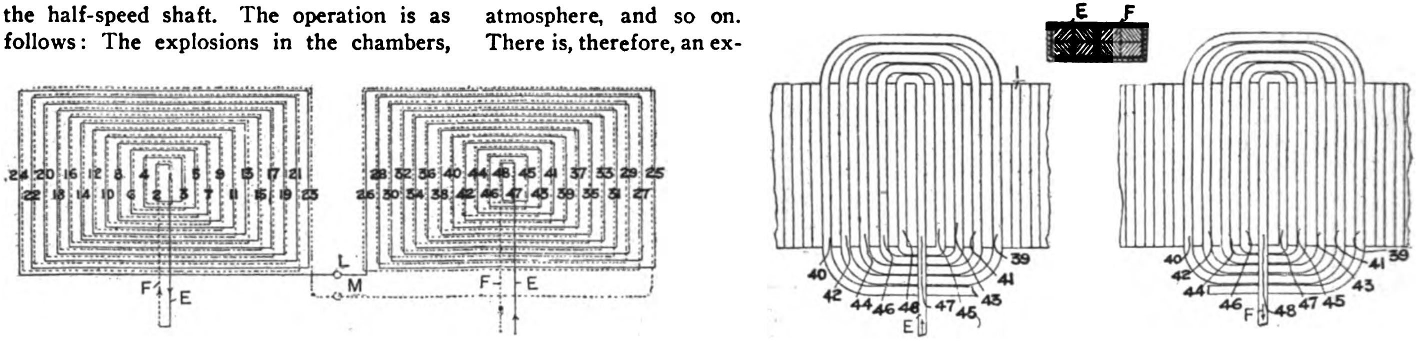


FIG. 12.—DIAGRAMMATIC VIEWS OF THE WINDING OF PARSONS AND STONEY'S GENERATOR.—FIG. 13.

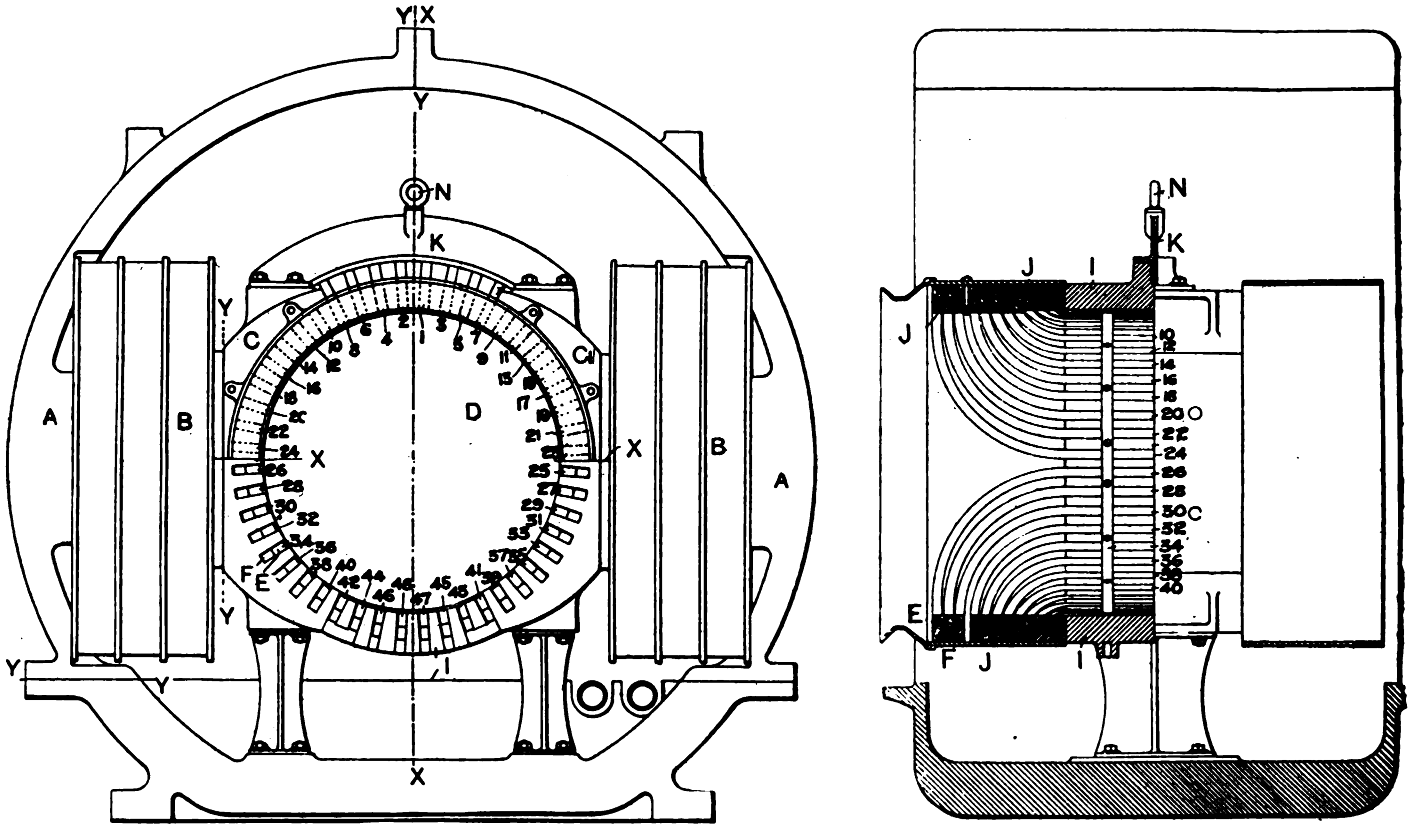


FIG. 10.—PARSONS AND STONEY'S DIRECT-CURRENT GENERATOR.—FIG. 11.

spirals on a cylindrical surface closely surrounding the armature, but giving clearance for its revolution. The coils, *E F*, where they occupy the polar faces, are embedded in open slots, 1, 2, 3, 4, etc., and between the polar faces are carried by non-magnetic segments *I* grooved for their reception. Beyond the magnets at each side the conductors pass in a direction perpendicular to the axis of the armature and are carried by cylindrical extensions, *J J*. The coils are shown diagrammatically in Fig. 12. The first coil, *E*, lies nearer to the armature in the slots, while the second coil, *F*, lies parallel with the coil *E* in the slots, but takes a different path between them, as shown in the developed views, Fig. 13, the true-developed view from the inside being obtained by superposing the left on the right. The coils *E* and *F* are shown in full and dotted lines respectively in Fig. 12. The current in the part of each coil in any slot in or between the pole faces will be opposite in direction to the current in the adjacent conductors in the armature. Fig. 13 shows a section of the conductors which tie in the slots as indicated in the lower half of Fig. 10. The coils, *E* and *F*, are divided along a horizontal diameter, *X X;* the upper half, 1, 2—23, 24, fits in the half-pole pieces, *C C*, and is also supported by the brass connecting piece *K* and extensions *J*. When it is desired to remove the armature the field magnet, *A*, with the shunt coils *B* are removed, the line of separation being marked by the dotted line *Y Y* in Fig. 10, binding screws *L M* connecting the upper and lower parts of the coils *E F* are then loosened, and the upper half of the coils with the piece *K* and extensions *J* can be lifted out by the eyebolt *N*. The polar plane of the coils *C F* coincide with the plane of commutation of the armature at no load.

High-Tension Fuses.—The *Elektrotechnische Zeitschrift* contains an account of a series of experiments made by a German manufacturing concern for the purpose of evolving a satisfactory fuse for high-tension circuits. The main difficulty experienced with high-tension fuses is that when the fuse melts metallic vapors are produced which are current conducting and form a bridge between the terminals of the fuse wire, resulting in an arc. The circuit, therefore, is not interrupted, the arc burning contacts and oftentimes flashing over to other metallic substances in the immediate vicinity. The main problem, therefore, is to extinguish the arc immediately. The first experiments were made with metallic fuse wire which was covered with a thick layer of tenacious cable compound. These were made into "cartridges," which gave excellent results up to 10,000 volts, passing 400 kilowatts. At greater capacities, however, they were absolutely useless, very violent explosions occurring. Fuse wire in oil was then tried, with fairly good results so long as a large basin of oil was employed. A fuse of convenient size was designed, having the form of a cylindrical glass tube of limited dimensions, which was filled with oil and contained the fuse wire. These, however, broke down with violent explosions, the oil being thrown out and the glass tube broken in many places. The violence of the explosion may be judged from the fact that glass tubes of 10 mm. thickness were broken and sheet iron of 5 mm. thickness was easily bent. The conductivity of the gas developed may be judged from the fact that at 5000 volts a spark jumps a distance of 70 cm. A fuse arranged as shown in Fig. 14 was finally tried with success. The features of this fuse are that the wire is placed in a chamber closed at the top and suspended at the bottom in oil. The fuse wire melts in air, but the explosive gases are driven downward into the oil. The glass tube is closed at both ends by metallic covers, the top cover being provided with holes for pouring the oil into the tube. The fuse wire is contained in the melting chamber proper, which is made of strong metal, as shown in Fig. 15. The chamber has a pinhole in the top through which the fuse wire enters, but is open at the bottom. The melting chamber is placed in the oil. The lower end of the fuse wire is electrically connected with the lower end of the glass tube and is also connected to this end by means of a spiral spring which holds the fuse wire in tension. The fuse wire itself is not in oil, so that when it melts, the spiral spring draws the lower end of the fuse wire downward and the explosive gases are immediately cooled in the oil. The result is that no arc is formed. The fuse is said to stand a continuous overload of about 50 per cent of the normal current and a short overload, up to five minutes, of about 70 to 80 per cent of the normal current. When loaded with double the normal current, it melts in less than two minutes. A number of the fuses have been installed in practice.

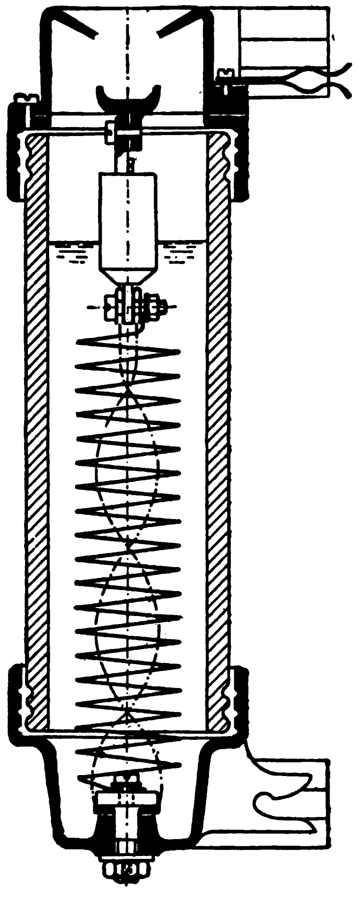


FIG. 14.—HIGH-TENSION FUSE.

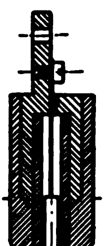


FIG. 15.

Single-Phase Wattmeter.—*L'Industrie Electrique* contains an illustrated description of improvements made in the Baltaut meter for single-phase systems. A U-shaped laminated electromagnet core is provided and the two ends of the arms are also U-shaped. The shunt windings are placed on the two arms of the main U and above these coils is placed a magnetic bridge, as shown in Fig 16. The series coils are placed on the arms of the two small U's, so that the polarities of the different magnets are as shown in Fig. 17. The combined action of the different coils develops eddy currents in a copper disc above the electromagnet. These react on the fluxes of the electromagnet so that a torque is produced which moves the needle on the dial of the meter. Since this torque is the result of the combination of the fluxes of the series and of the shunt coils, it is proportional to the energy to be measured. The angular speed of the disc is rendered proportional to the torque by adding a permanent brake magnet, which acts on the disc. The arrangements were formerly so made that the air-gap could be changed in order to vary the braking action. Now the air-gap is held constant. For regulating purposes the permanent magnet can be moved in the direction of the radius of the disc so that a greater or smaller flux

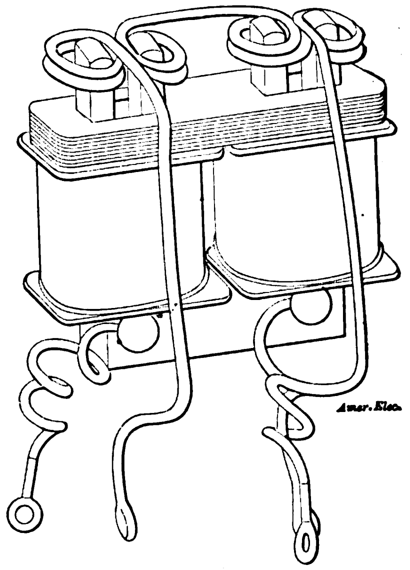


FIG. 16.—SINGLE-PHASE WATTMETER MAGNETS.

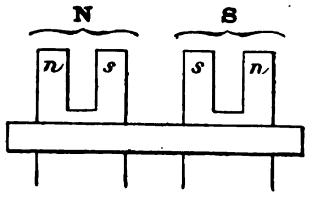


FIG. 17.

of the magnet acts on the disc. There is also provided a small iron piece which may be brought nearer the one or the other pole of the electromagnet, resulting in lack of symmetry of the field and in a small torque. If the meter shall be exact for a circuit with phase difference, it is necessary that the fluxes produced by the series and shunt coils respectively be in quadrature. This condition is fulfilled by placing on the poles, *N* and *S*, short-circuited windings which surround them completely. A 500-ampere meter of this type is started by a single 16-cp lamp.

SOME RECENT ELECTRICAL PATENTS

Self-Starting, Single-Phase Induction Motor. —Fig. 1 illustrates the latest attempt to provide a self-starting, single-phase induction motor; the inventor is M. C. Massie. The motor, *B*, is provided with a double-wound stator, like that of a machine intended to be started by means of a phase "splitter," and a rotor having a squirrel-cage winding and also an ordinary closed-circuit or ring winding. The latter is connected to two pairs of collector rings, one for running forward and the other for opposite rotation. A rotating field is set up in the stator by means of a peculiar transformer, *T*, having a stationary primary winding and two secondary windings, the latter mounted on a revolvable core like the armature of a motor. The two secondary windings are set at right angles to each other; consequently, when one is in position for maximum induction the other is in the neutral position. The transformer armature is mounted on the same shaft with, or otherwise rigidly driven by, the rotor of the induction motor *B*. The taps from the collector rings of the motor to its ring winding are located so that when one of the transformer secondaries is in the most favorable position and is delivering maximum e.m.f. to the corresponding stator winding on the motor, the polar axis of the rotor ring winding is in the most favorable position for torque, due to the field of the then active stator winding. The machine, therefore, starts up, and the rotation of the transformer armature produces a rotating field in the motor stator which is always just ahead of the polar axis of the rotor ring winding. The switch, *I*, is for reversing the motor by shifting the rotor supply current to the other pair of slip rings. The adjustable inductance, *I'*, is for regulating the torque of the rotor. At full speed the switch, *I*, is opened, leaving the machine a simple induction motor. Patent No. 763,774.

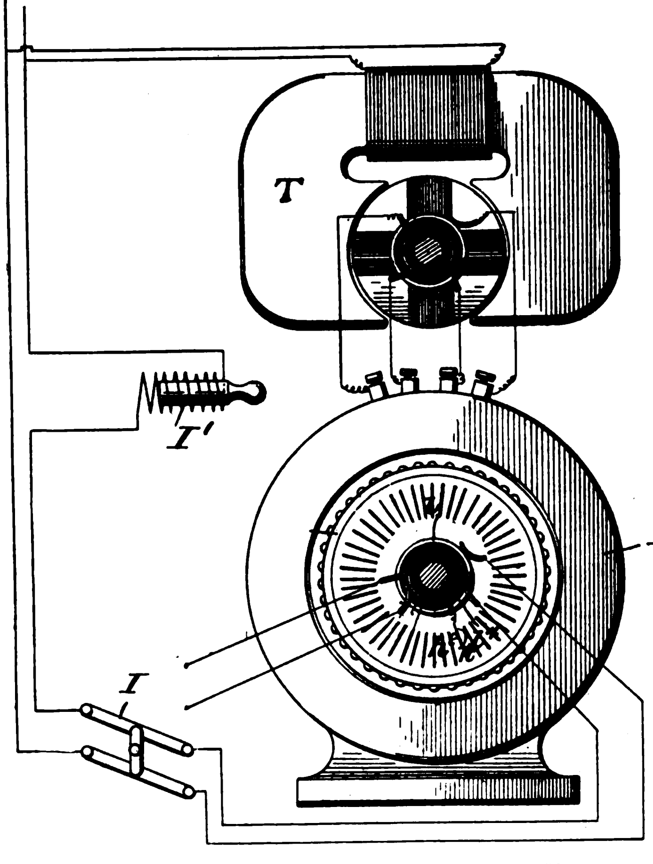


FIG. 1.—SELF-STARTING SINGLE-PHASE MOTOR.

Extinguishing Electric Arcs.—Numerous attempts have been made to provide means for entinguishing the arc drawn by the opening of a circuit carrying considerable current at moderate and high potentials, with varying success. One of the best-known means is the electromagnet, applied so as to blow out the arc. The inventor of this method, Prof. Elihu Thomson, has now devised another and simpler method, consisting of interposing non-combustible and non-conducting material between the electrodes: in short, choking off the arc mechanically. Fig. 2 shows the application to an automatic circuit-breaker. The main contacts are made, as usual, by means of a laminated metallic brush, 27, and the circuit is opened by means of supplementary contacts. In this case the latter are metal blocks, 2, 5, 5, the first mentioned block sliding between the other two. When the circuit-breaker is opened, the parts take the positions shown in the diagram; the arc which would otherwise follow from the stationary blocks, 5, 5, to the sliding block, 2, is cut off by the block of non-conducting material, 3, attached to the moving member, and the similar stationary blocks, 8, 8. The material used to cut off the arc is fused quartz. Patent No. 751,028.

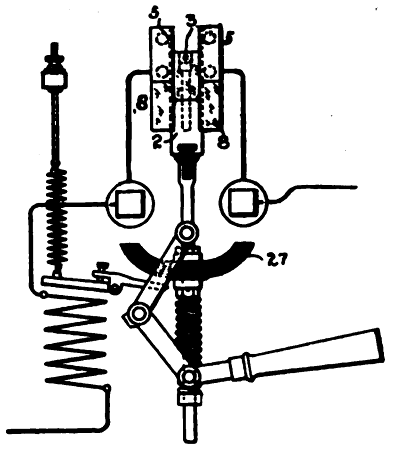


FIG. 2.—ELECTRIC ARC EXTINGUISHER.

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NOTES.

Electric Traction on Lackawanna Railroad.—It is reported that the Lackawanna Railroad is contemplating the experimental operation of two storage battery cars on its Montclair branch. The cars are to be equipped with Edison storage batteries and the plan is to run the cars between Newark and Montclair during the middle of the day when traffic is light; the distance between the two cities is between 5 and 6 miles.

Power Consumption of Elevators.—The New York Edison Company, in a recent issue of its admirable little *Bulletin*, gives the following figures taken from tests of direct-current passenger elevator motors:

No. of test.	Lifting Capacity	Speed per minute	Days Covered by Test	Average Consumption of Current per car mile
	Lbs:	Feet:		Kw-hours:
1	1500	175	31	2.2
2	1500	175	29	1.67
3	2000	225	21	1.54
4	2000	225	21	1.77
5	2000	150	21	3.6
6	2000	250	30	3.12
7	1000	250	26	2.14
8	1000	250	30	2.41
9	1500	250	24	2.97
10	2000	250	30	3.38

Underwriters' Rules for Electric Car-Wiring. —The Underwriters' National Electric Association has issued a supplement to the Code relating to electric wiring, the supplement containing rules covering the wiring of electric cars. As this is a rather special branch of electric wiring, copies of the supplement have not been distributed generally and the first edition has been limited to 10,000 copies. Anyone needing a copy of the supplement may obtain it on application to the National Board of Fire Underwriters, 32 Nassau Street, this city.

International Electrical Congress Plans.—The American Institute of Electrical Engineers has arranged a most attractive tour for the pleasure of foreign engineers who are expected to attend the St. Louis Exposition during the International Electrical Congress. This tour includes visits to Schenectady, Montreal, Niagara Falls, Chicago and Springfield, Ill., on the way to St. Louis. At the close of the Congress, the tour will be resumed, taking the participants to Pittsburg, where the Westinghouse factories will be visited, thence to Washington for a day's sight-seeing, to Philadelphia, and back to New York. The special train making this tour will leave New York at 8.45 a. m., September 6th, arriving at St. Louis at noon, September 11th (Sunday). The Congress opens on the following morning and will close on Saturday, September 17th, as stated in previous issues. At 8 p. m., the same day, the special train will leave St. Louis for Pittsburg, Washington, etc., arriving at New York at 5.30 p. m., Wednesday, September 21st. Arrangements have been made whereby tickets may be bought to cover the entire itinerary, including hotel accommodations in the various cities visited, for $150 each.

Wireless Telephony by Means of Hertzian Waves.—Some interesting experiments were recently made by a Spanish engineer, Mr. G. J. de Guillén Garcia, together with his son. In connection with some wireless telegraphy researches the son of the experimenter happened to note that in the telephone of the Tommasi coherer located at the receiving station, there was a sound difference according to the air-gap in the interrupter of the Rhumkorff apparatus. This suggested the idea that a similar apparatus would be susceptible of transmitting the human voice to a distance without the agency of the wire, and after some delay Mr. Garcia tried the experiment.

The experimental arrangement is a rather simple one. At the transmitting station there was a Rhumkorff coil giving a spark 1 3-16 inches in length, as well as the necessary oscillator, a small antenna and a grounded conductor. Between the induction coil and a small battery of Grenet cells there was a special microphone, acting both as transmitter and as interrupter. The automatic interrupter of the induction coil was stopped and the condenser was used for enhancing the oscillator spark.

At the receiving station, there was a Tommasi coherer connected to the receiving antenna and the grounded conductor. In a telephone receiver the noise produced by the Hertzian waves on traversing the coherer was plainly heard. On applying the mouth to the microphone and singing or speaking, every sound vibration was attended by an interruption in the passage of the electric current through the primary circuit of the induction coil, the number of sparks at the oscillator thus being varied. The underlying principle shows, therefore, some analogy with the mechanism of an ordinary telephone.

The results so far obtained in the reproduction of singing tones are said to be quite satisfactory, but the transmission of speech leaves much to be desired. The weak point seems to be the difficulty of designing a microphone of sufficient vigor, so to speak. Mr. Garcia, it is true, has remedied the imperfections of his apparatus to a certain extent by the use of a condenser; this, however, could not be carried too far, lest electric arcs be formed.

Experiments With 70,000-Volt Direct and Alternating Currents.—Some interesting tests were recently made by the Compagnie de l'Industrie Electrique et Mécanique, Geneva, Switzerland, with very high-tension direct currents. Three direct-current dynamos, one of which gives 20,000 and each of the other two 25,000 volts, were connected in series in the laboratory of the company, to get 70,000 volts. Each of the three dynamos had a maximum capacity of 1 ampere, so that 60 to 70 kilowatts were available; this was more than sufficient for obtaining comparative data. The behavior of insulators with respect to direct and alternating current was especially investigated, a special alternator being constructed to yield 75 kilowatts. The conditions were rather unfavorable for the direct-current tests on account of the armature coils being arranged in the slots of a toothed ring, so that the self-induction was increased and current oscillations produced. In spite of these disadvantages, the results of the experiments are highly in favor of direct current. All the insulators used were found to stand much higher direct-current than alternating-current voltages, and the same may be said of insulating substances submitted to piercing tests. Moreover, no considerable heating effect was observed in the case of insulators exposed to the action of direct current, while the opposite was true with alternating current; this seems to be due to the absence of any capacity effects in the case of direct current. With direct current the crackling noise produced by alternating current on approaching the limiting tension the insulator is susceptible of was not heard, and no glow was noticed until the breakdown distance was approached quite closely.

Ordinary insulators, such as those used for telegraphic purposes, as well as insulators such as have been used for years past in connection with power transmission over moderate distances, were not perforated by 65,000 volts direct-current e.m.f. The tests indicated that the porcelain, however, should be well vitried and homogeneous, whereas the thickness matters little. Glass was found to be difficult to perforate with direct current, ordinary white glass of 0.3 mm. withstanding very well potentials as high as 25,000 volts, while a disc of plate glass was found to stand upward of 60,000 volts direct-current tension. When the insulators were tested in the laboratory, being protected against atmospheric influences, the limiting voltage could as an average be driven up to 1.63 times that in the open air after 24 hours of dense rain.

Convention of the Canadian Electrical Association. —At the fourteenth annual convention of this association, held recently in Hamilton, Ontario, there was a very large attendance, and a number of practical papers were read. Among these was a most instructive one by Mr. W. L. McFarlane, on "Alternating vs. Direct-Current Arc Lighting System." The author stated that, for reasons apart from arc lighting, the tendency at present in equipping electric power stations is toward the installation of alternating-current generators of large capacity. The source of power may be water or steam, or a combination of both; and when, as is often the case, a combination of engines and water power has to be used, transformers and lamps, or motor-driven arc dynamos are possible as in the other two cases, there being also possible the arrangement whereby the arc dynamos are operated from line shafting to which are connected both an alternating-current motor and an engine, by means of suitable clutches or quills, either the motor or the engine being used to supply the necessary power to the shafting. Generally speaking, there are four systems of series arc lighting at present in use, as follows: (1) The small arc dynamo supplying about 50 open lamps at 9.6 or 6.6 amperes. (2) The larger and more modern arc dynamos supplying as many as 175 open lamps in series or by the multi-circuit arrangement. (3) Large arc dynamos wound for 6.6 amperes for supplying current to enclosed lamps. (4) Transformers to which are connected circuits having as many as 100 constant-current, series-alternating, enclosed arc lamps.

The maximum candlepower of the open arc is higher than that of the enclosed arc, but the light is not so steady owing to the more frequent feeding of the carbons, their poorer quality, and the action of the wind on the arc. Owing to the shortness of the open arc, and to the fact that most of the light comes from the crater of the upper carbon, this light is in a downward direction, being greatest at an angle of about 45°, while a large area under the lamp is poorly lighted and affected by shadows. In the enclosed arc the wandering of the arc is the main cause of what variation there is in the light, but by the use of an opal inner globe these variations are greatly reduced. The increased length of the enclosed arc allows the light to diffuse in a more horizontal direction, the result being much less light in the immediate vicinity of the lamp, but a slightly increased amount midway between lamps.

The "Question Box," edited by Mr. A. A. Dion, of Ottawa, created a great deal of interest and brought to that gentleman a well-merited vote of thanks from the association for the time and trouble devoted by him to preparing the questions and securing the answers in the published volume of the Question Box.

The election of officers resulted as follows: Mr. K. B. Thornton (Montreal), president; Mr. A. A. Wright, M. P. (Renfrew), first vice-president; Mr. George Black (Hamilton), second vice-president; Mr. C. H. Mortimer (Toronto), secretary-treasurer. The Executive Committee consists of Messrs. A. B. Smith, Gordon Henderson, J. A. Kammerer, John Murphy, J. J. Wright, A. A. Dion, B. F. Reesor, C. B. Hunt and Fred Thompson.

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The Variable Speed Motor.

The article on this subject which we print elsewhere in this issue emphasizes several points of interest in connection with speed regulation in electric motors. One of these is the fact that regulation by varying the counter e.m.f. per revolution, without varying the current capacity, is the only method which enables the motor to develop its full power at all speeds. This, of course, is not news to anyone at all familiar with motors. It does not appear always to have received as much consideration as it might have, however, in view of the well-understood fact that the availability of full power at low speeds is a very great advantage in some classes of motor application. As Mr. Hemingway states plainly enough, the bugbear in securing wide ranges of speed by means of ordinary field variation is that at the higher speeds one encounters serious commutation difficulties; and the most obvious method of varying the counter e.m.f. by varying the number of armature conductors is utterly impracticable beyond very small limits. His method of varying the counter e.m.f. by applying an auxiliary magnetic field to the armature and regulating this to assist or oppose the e.m.f. induced by the main field throughout a graduated range is certainly ingenious; whether or not it would be practicable from a purely commercial standpoint can be determined only by trial.

There are at least two practical machines on the market, however, in which the counter e.m.f. of the motor is regulated over a wide range without developing any difficulty at the brushes. In one, the field magnetism is varied over the central part of the pole-face without appreciably affecting the density of the pole-tip fringe and without involving appreciable field distortion; the field variation is effected by purely mechanical means. This machine, obviously, embodies one solution of the problem of securing full output at all speeds. In the other there are two armature windings, each of the same current-carrying capacity, but containing very different numbers of conductors; these are connected to two commutators, and the controller puts either one or the other winding in circuit alone, the two in series cumulatively, or in series differentially. The result is four speeds, covering quite a wide range, at all of which the full output is available; intermediate speeds are obtained by varying the field excitation slightly. Obviously, the machine commutates just as well at one speed as another, excepting those at which the field is weakest; it is, of course, designed for commutation at those speeds, and therefore commutates properly at all others.

Mr. Hemingway's suggested machine evidently is analogous to this last-mentioned motor so far as results are concerned, although one of these results is obtained in a different way, and does not cover so wide a range. He varies the effective proportion of the total armature winding by inducing either an assisting or an opposing counter e.m.f. in it with the auxiliary field magnet poles, and gets intermediate speeds by grading the auxiliary field strength; the latter is practically the same as grading the strength of a single field system.

In all cases, excepting possibly the type embodying field variation by altering the flux in the central part of the pole-face, a multispeed machine giving its rated output at all speeds must necessarily be heavier and more expensive than a constant-speed machine of the same output. It is merely a question as to what method entails the least additional weight and shopwork to produce the motor and its controller. As to the possible exception just noted, we have not sufficient "inside information" to enable us to express an opinion; in the abstract we should think that the foregoing statement would apply to any type, on the principle that one cannot expect to get something for nothing.

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Erratic Engineering Development.

It is interesting and curious to note how indirect is the development along some engineering lines. The alternating-current generator, for example, was the first type to be actually built for commercial purposes. The old "Alliance" alternator of Du Moncel, which was used for lighthouse service from 1863 for many years, was the development of a machine devised by Nollet in 1849. Probably the first direct-current machine of any considerable output was the one built by Holmes and exhibited at an Exposition in 1862, but that was remodeled a few years later into an alternator. Notwithstanding this excellent early start, direct-current apparatus reigned supreme from the time when electric lighting really began to amount to anything until the invention of the transformer—or, rather, the waking up of Gaulard and Gibbs to the fact that the long-known induction coil is a transformer.

The steam turbine is another example of delayed development. Hero's revolving sphere was essentially a steam turbine, of course. The fundamental features of the present De Laval and Parsons turbines were disclosed in an English patent issued to one Pilbrow in 1843, and the principle of compounding for velocity, embodied in the Curtis and Stumpf turbines, was described by Robert Wilson in 1848. Most of the early turbine inventors, too, seemed to have very clear-cut and comprehensive ideas as to the practical requisites of successful turbine design, but none of them ever succeeded in reaching an industrial status. It is thought by the editors of *Engineering* (London) that one of the principal reasons for this failure might have been the lack of facilities for doing the extremely accurate machine-tool work that is indispensable to successful turbine operation. It is highly probable, however, that the inherently high velocities necessary to good economy had much more to do with retarding turbine development than any other one feature; the transition from seventy-five to several thousand revolutions per minute was entirely too startling, even if it had been possible to get the grade of workmanship essential to high speeds and small clearances.

The belated recognition of the gas engine is still another curious feature of engineering progress. It has been about forty years since Beau de Rochas pointed out the vital requisites to economical gas engine operation, and we are just beginning to get a dim conception of the actual possibilities of the machine. One reason for this, of course, is that industrial conditions have only within comparatively few years been such as to force attention to the problem of cheapening power conversion; this, too, is one of the reasons for the delayed developments in the other branches mentioned. Still, it seems almost absurd to have allowed the gas engine to lie practically unutilized for almost half a century while everyone concerned knew at least the superiority of the machine as a converter of heat energy into mechanical work.

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High Potential Direct Current.

In another column will be found a brief account of some tests on insulators made by the only advocate of direct-current high-tension transmission in the world: M. Thury's Compagnie de l'Industrie Electrique et Mecanique, of Geneva, Switzerland. These tests show, as one might naturally expect, that many of the drawbacks incident to the insulation of high alternating voltages are much less formidable in the case of direct current, and some of them disappear entirely. Though one is strongly tempted to apply the current slang expression of forlorn hope: "What's the use?" in this case, it is impossible not to admire the courage and persistency with which this lone enthusiast has followed up his convictions; one even feels a tendency to share M. Thury's hopeful faith in direct-current transmission, notwithstanding its apparent lack of scientific justification. And when the intrinsic attractions of direct-current transmission are considered, it is really not to be wondered that strong efforts have been made to reduce it to a practical status.

It is, of course, a matter of common knowledge that the fundamental obstacle in the way of successful direct-current transmission is the commutation of high voltages. The flexibility of alternating-current transformation is a tremendously advantageous feature of that class of plant, but if direct high potentials could be produced by machines of a few thousand kilowatts capacity it is very safe to say that many engineers would put up with the expense of installing and maintaining direct-current rotary converters rather than struggle with the difficulties attendant upon very high tension alternating-current transmission. We are free to confess that the solution of the high-voltage commutation problem seems hopelessly remote; even commutation at ordinary voltages has not been brought to a point where there is any unanimity of opinion as to the requisites for success. Nevertheless, we sympathize with M. Thury in his struggle and sincerely hope he may conquer the enormous odds against him and compel complete success.

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The Value of Education.

A reader recently asked the question: "How can a graduate of a correspondence school expect to get a position when there are so many experienced engineers looking for work?" The answer is obvious: he can't—merely on the strength of being a technical graduate. But if the school is a good one and the man has the right qualities his chances of getting a good position will be about ninety-nine times greater than if he did not have the learning. Technical education not only confers the benefit derived from all classes of systematic mental training but it enables the possessor to save an enormous lot of valuable time in "getting on," by avoiding the mistakes that would otherwise be inevitable and by attacking his work intelligently and confidently instead of dubiously and blunderingly. We do not believe there is a solitary position in the whole field of engineering the holder of which cannot, by means of education, immensely increase the chances of improving his lot.

It is a grave mistake, however, to imagine that the possession of a diploma or other certificate of technical learning is a guarantee of flowery success. Hundreds of misguided parents are bestowing on their male children special educational advantages which will merely serve to condemn them to a professional mediocrity that is more humiliating than the lowest grade of manual labor. The personal qualities and natural fitness of a man have vastly more to do with his success than mental training. All this, however, does not in the slightest degree affect the question of whether or not education is advantageous to a man who is, or expects to be, engaged in a certain line of technical work; there is no more room for doubt on this score than there is reason to question the law of gravitation. Given two men of equal inherent worth, one having special education in his line of work and the other being without it, with absolutely equal chances otherwise, the educated man is as sure to leave the other far behind as a rock is to fall toward the earth when released in air.

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The Alternating-Current Cycle.

Any succession of operations that brings the operator back to the starting point, ready to repeat the series, is a cycle. Thus, if one should take an elevator at a given floor of a building, ride up to the top of the building, then down to the basement, and then back up to the floor at which he started, he would have passed through a "cycle" of elevator travel. Similarly, when a gas engine, starting at the point when the cylinder is empty, takes in a charge of gas and air, compresses the charge, ignites it and lets the expansion of gases drive the piston forward, and finally exhausts the burned gases, leaving the cylinder empty and ready to take in another charge, it has passed through one cycle of its routine operation. Now, when an alternating current rises from zero to its maximum value in one direction, falls back to zero, reverses and rises to maximum in the opposite direction, and falls to zero again, it has passed through one cycle of its regular operation. The cycle was not complete when the current fell to zero after rising to maximum the first time because it had not been through the rise to maximum in the other direction and was, therefore, not precisely at its original starting point, ready to rise in the first direction again.

DESIGN FOR A CHANGE SPEED GEAR FOR MOTOR-DRIVEN VEHICLES.

BY J. E. PFEFFER.

Up to the present stage of development of the gasoline motor vehicle it has been found impracticable to connect the motor unalterably to the driven axle. It has been, and probably will long be, necessary to provide some form of conveniently operated mechanism for varying at will the ratio of the motor speed to the speed of the traction axle. In order to accomplish this end with the greatest degree of efficiency, convenience and noiselessness and with a minimum of wear and tear the resources of mechanics have been thoroughly canvassed, with the result that numerous means, which could by any possibility serve the purpose, have been adapted and given more or less trial. Among the ways and means of effecting the movements upon cars that have to be controlled by non-mechanical, or at least somewhat unskilled persons as well as the "handy" expert, the sliding clash gear system has proved by far the most popular of all methods for use on high-grade motor cars, due to its compactness, ease of enclosure, positiveness and strength, and requiring no adjustment in its entirety. It is, at times, objected that it is difficult to force the gears into mesh without delay, noise and battering of the opposed tooth faces. This is true, however, only when gears of too small pitch, improper tooth outline and badly beveled faces are employed.

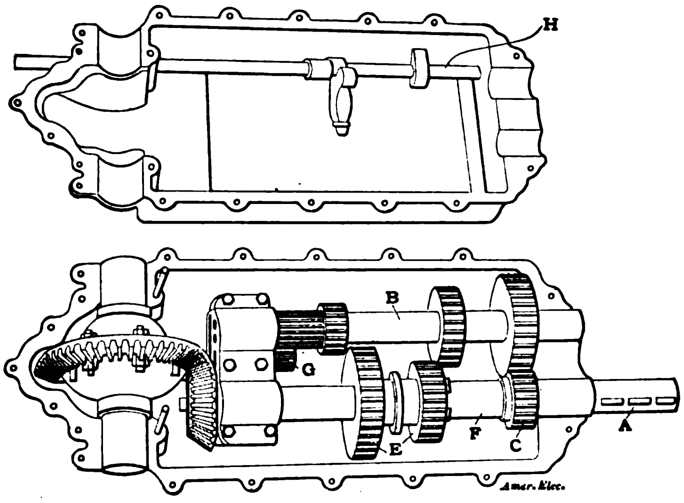

FIG. 1.—CHANGE SPEED GEAR AND CASE.

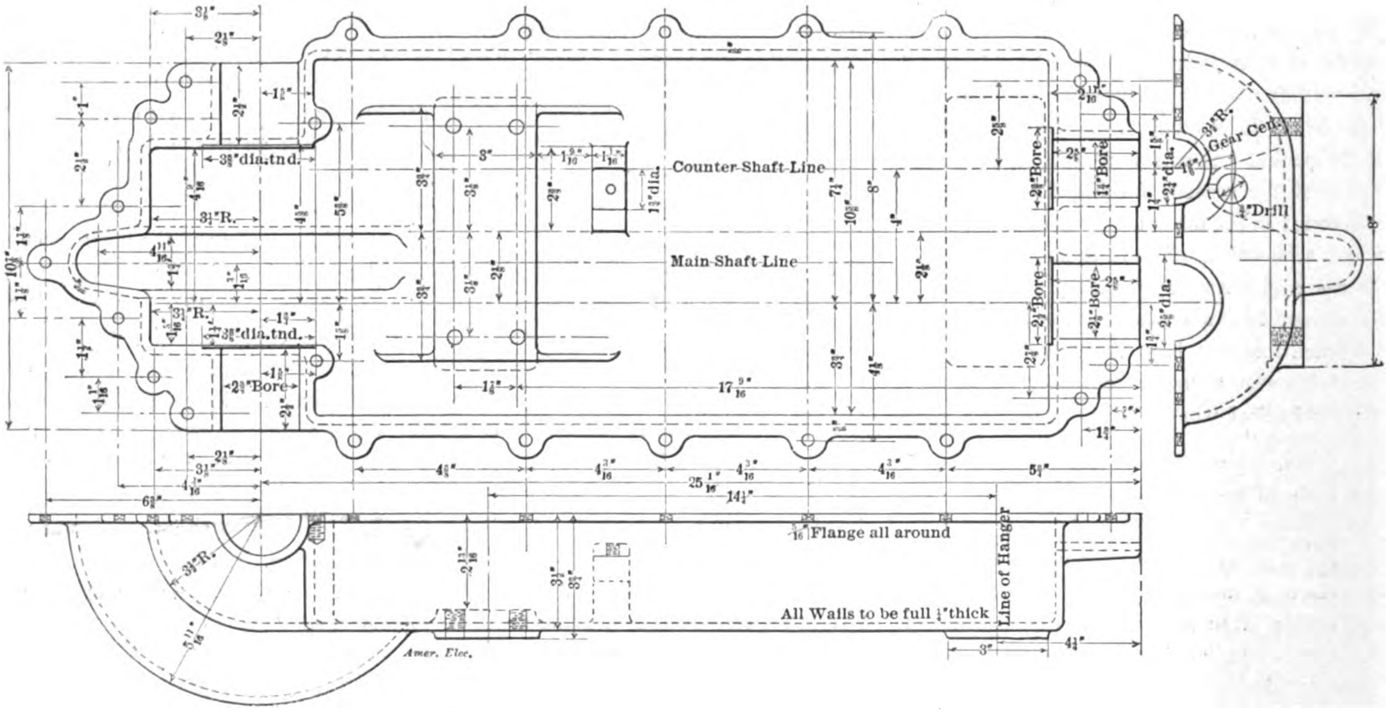

FIG. 2.—GEAR CASE DETAILS.

In this connection it is well to note that in these speed-changing gears employing two parallel shafts with the speed ratio varied between them, the sums of the diameters of any pair of gears which are ever in mesh must be equal. As the name indicates, in this sliding clash gear system the gears are not maintained in permanent mesh for any two speeds controlled thereby, but different pairs are engaged at will by a sliding motion of the sliding gear, causing either the teeth of the one gear to enter the tooth spaces of the other, or a similar action between the crab teeth of clutches for the case of the direct or high-speed arrangement.

The accompanying working drawings show a design used on various types of touring cars, ranging from 20 to 30 horsepower, which is so constructed that it may be readily adapted to any side chain driven car without any change in detail whatsoever. It is very simple, has 3 speeds forward and 1 reverse, operated by 1 lever. The speed ratios are 1 to 1, or direct, on high speed, 1¾ to 1 on second speed, 4 to 1 on third speed, reverse 5 to 1. The full movement of the shift gear in making these various combinations is 7 inches and its entire operation depends upon a one-movement connection, termed the one-lever control. A good idea of the assemblage of the gears and shafts in position in the lower case can be gleaned from Fig. 1. The main shaft, *F*, here takes a bearing inside the gear wheel, *C*, which in turn is rigid with the stub shaft, *A*, to which the motive power is to be connected. The wheel, *C*, has jaw clutch members formed on its inner side to correspond with those on the rear side of the sliding gear, *E*, which is carried upon the shaft, *F*, capable of sliding along its length but made fast against turning upon it by virtue of the squared portion of the said main shaft. The engagement of these corresponding jaw clutches gives the direct or high speed, when none of the spur gears are transmitting power, since the power shaft, *A*, is now directly coupled to the cross shaft drive pinion.

For the intermediate, the slow speed and the reverse, a lay shaft, *B*, parallel to the main shaft, has fixed upon it three spur wheels, the use of either one of which in the transmission of power to the bevel drive pinion, depending upon the longitudinal position of the sliding gear, will serve to get one of the required reduction ratios between the power shaft and the bevel drive pinion. These gears are of such size and so spaced along the lay shaft that only one pair of gears can be brought into mesh at the same time when the sliding gear on the main shaft is moved. The arrangement of this system of variable speed gears is such that by progressively moving the sliding gears the smallest gear on the main shaft first comes into mesh with the largest gear on the lay shafts giving the low gear or greatest reduction ratio. As these gears slide out of engagement, the larger of the sliding gears on the main shaft is ready to enter its teeth into the tooth spaces of a smaller one on the lay shaft giving a higher gear and a smaller reduction ratio. The spacing is such that when one gear slides out it will not come into contact with another by the continued motion of the sliding gear. The reverse is obtained by sliding the main shaft gears into mesh with the idler, *G,* Fig. 1, which in turn is constantly engaged with a suitable gear on the second shaft.

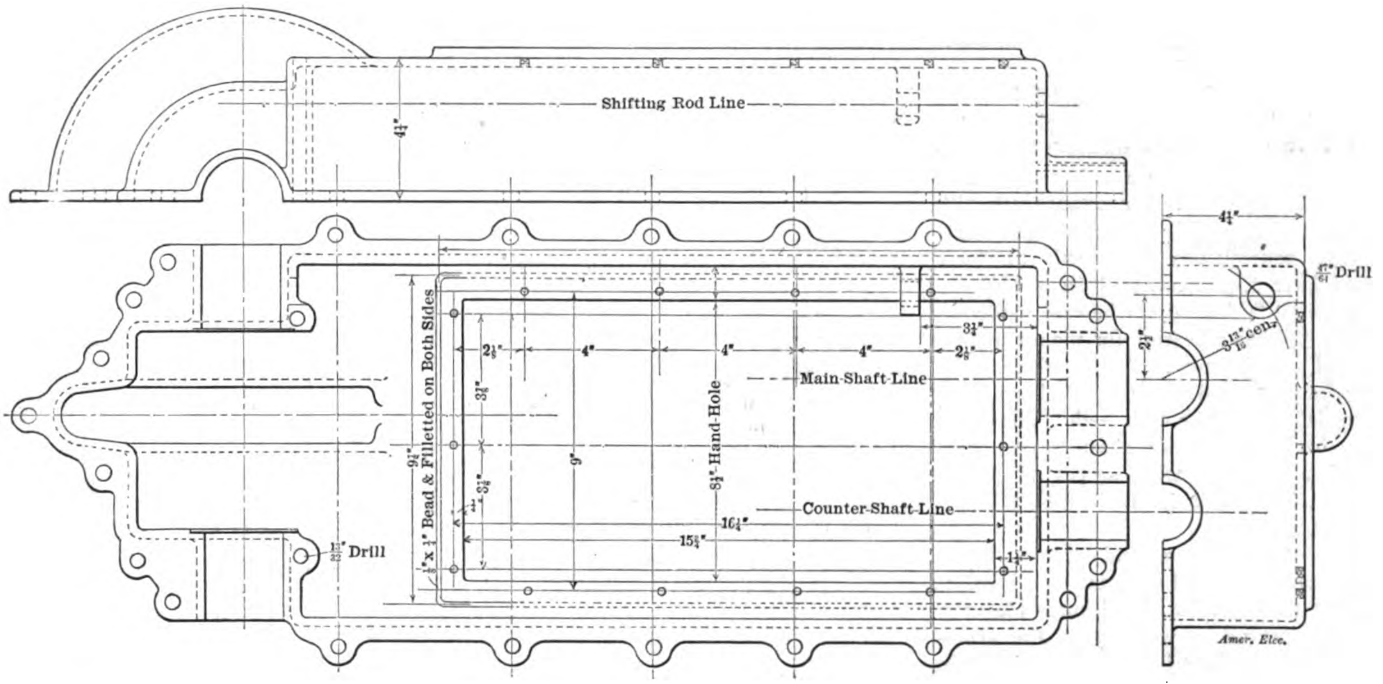

FIG. 3.—GEAR CASE DETAILS.

The case for the transmission system consists of two castings, marked Detail "Y" and Detail "Z." These are intended to be made of aluminum-zinc alloy containing about 25 per cent. of zinc. They can be made of cast iron where it is desired to reduce the cost rather than the weight, and should then be made considerably thinner (about 3-16 in. thick). The horizontal joint between the bottom and cover of the case passes through the center of the main bearings. The bottom portion, Detail "Z," has two downward projecting bosses to serve as feet for bolting it to cross hangers stayed to the side members of the main frame of the car. By this arrangement suitable hangers can always be made to properly hang the gear without any alteration on the case.

In finishing Detail "Z" the hanger bosses are first to be planed to the given size, then the bolting surfaces of both halves should be finished. The bolt holes in the bolting flange may then be drilled and the two halves bolted together, after which the seats for the various shafts may be bored. This latter boring should, of course, be done with one setting, and particular care be exercised to have the cross and other shaft bearings at right angles in the same plane. Particular care should also be taken to make a tight job of the joint in the case without the intervention of a separate gasket or packing, relying only on the careful surfacing of the metal and the bolts for drawing the parts together. The case containing studs, Detail "O," introduced for the prevention of any springing apart of the case about the bevel gears, should be tightly screwed into the case bottom to such a length as to allow about 1-16 in. extension above the nut after the cover has been slipped on and the nuts screwed up firmly.

The bearing pedestal supporting boss in the bottom of Detail "Z" should have ample filling provided for at the corners in making up the pattern, in order to insure the finishing indicated to provide a seat and in consequence avoid any transverse motion in the pedestal. The tap holes for this should be drilled before the drilling of the corresponding holes in the pedestal, so that they may serve as guides in laying out the latter.

The inspection hole in the top of the case cover is to be covered with Detail "V," made out of sheet steel. No finishing is here necessary for the joint other than rasping out the contact surface within the bead on Detail "Y" with a hand surfacing tool. Practice has demonstrated the advisability of this, for any oil that may find its way through the joint proper is satisfactorily restrained by the housing provided by the surrounding bead. However, in extreme cases, as when using a very light oil, small asbestos rope packing may be inserted around the outside of the cover screws.

The bronze bushings, Details "E," "F," "G" and "T," for the shaft bearings should be carefully fitted to the different seats in the case, to avoid any possible leakage of oil or looseness in the bushings. These bushings are held fast from turning by dowel pins (Detail "W") inserted in the case bottom to match holes given in the bushing details. Detail "F" is closed at the outer end by a separate piece as shown, to provide a dust-proof, oil-tight box for this dead ended shaft. All oil grooves in bushings shown in detail should be fully observed to insure the necessary lubrication for these close-fitted bearings.

The idler shaft, Detail "N," supported by the bearing pedestal, Detail "R," and the lug in the case bottom, is held fast by the retaining set screw in the top of said lug. In placing this shaft the gear centers should be observed and the idler gear made to revolve freely without lateral movement on the shaft.

The gear shifter shaft, "Detail "P," shown in position at *H,* Fig. 1, is contained in bearings in the ends of the case cover and specially located lugs on the side of the case cover. This drilling should be done with a long shank drill from one end to insure proper alignment. While inserting the shaft, the shifter fork, Detail "Q," should be slipped on while being held in the groove between the gears on the sliding gear, Detail "D." To locate this fork correctly along the shaft, place the shifting gear in the clutch, *C,* Fig. 1, with the shifter shaft about 1-16 in. through on the outside of the cross shaft end of the case, and tighten up the set screw in the shifter fork firmly.

The bearing pedestal, Detail "R," should first be planed at the bottom, then the surfaces of both the pedestal and the cover, Detail "S," where they bolt together should be finished. The bolt holes in these bolting flanges may then be drilled and the two parts screwed together, after which the bearing seats for the shafts and the seat for the idler gear shaft may be bored. Dowel pins should then be placed in the bottom of the pedestal bearing seats so as to correspond to holes in Details "G" and "T" of the bushings. One end of the main shaft-bearing hub on the pedestal and cover is indicated to be finished in order to supply an end-thrust bearing surface for the bevel-drive pinion. This finishing should be done with the pedestal and cover bolted together after the boring of the bearing seats in same. Before drilling the retaining set screw holes on the base of Detail "R," the bottom ends should be fitted carefully to the planed seat in Detail "Z," after which the set screw holes can be marked to correspond to tap holes in the case bottom with shafts in position.

The engine-driven pinion, Detail "C," is provided with a stub shaft and a set of crab teeth for the direct-drive engagement with the sliding gear. To the stub shaft the motor connection with the intervention of an operating friction clutch is made, either by keys or by the squaring of the stub shaft to which the square-holed sleeve of the clutch direct or a universal joint is fitted. This pinion is in constant mesh with the gear, Detail "I," as is also the reverse pinion, consequently the teeth of these gears have square-cornered faces, and except Detail "C," need not be case hardened. Detail "C" has a bearing for the main shaft bushed with bronze, as shown, which bushing should extend out to be flush with the extended end of the crab teeth. The clearance back of the main shaft end when in position in this bearing serves adequately as an oil reservoir for lubricating this important bearing.

The shifting gear and clutch, Detail "D," requires special attention and involves a great deal of labor, but insures the most reliable method of working by the avoidance of all feather key work in the most important member. The crab teeth on this should be carefully fitted to engage freely with Detail "C," and should be slightly beveled off at the outer extended corner, as indicated, so that a free sliding over may be had on the bushing sleeve during engagement with Detail "C." The faces of the teeth of this sliding gear should be carefully beveled and hardened, so as to enter into mesh with their mates readily and not be subjected to deformation; then, as the operating clutch of the engine is always out and no power being transmitted when shifting of gears occurs, these gears have no power but their own momentum and consequently their teeth should enter the tooth spaces of their mates at all times without danger of breakage.

The lay shaft second speed gear, Detail "J," the third gear, Detail "K," and the reverse idler pinion, Detail "H," should for the same reason as given for the shifting gear have their tooth faces beveled and hardened.

The distance sleeves, Details "L" and "M," are specified to be of cast iron, but can be made of any convenient tubing fitted

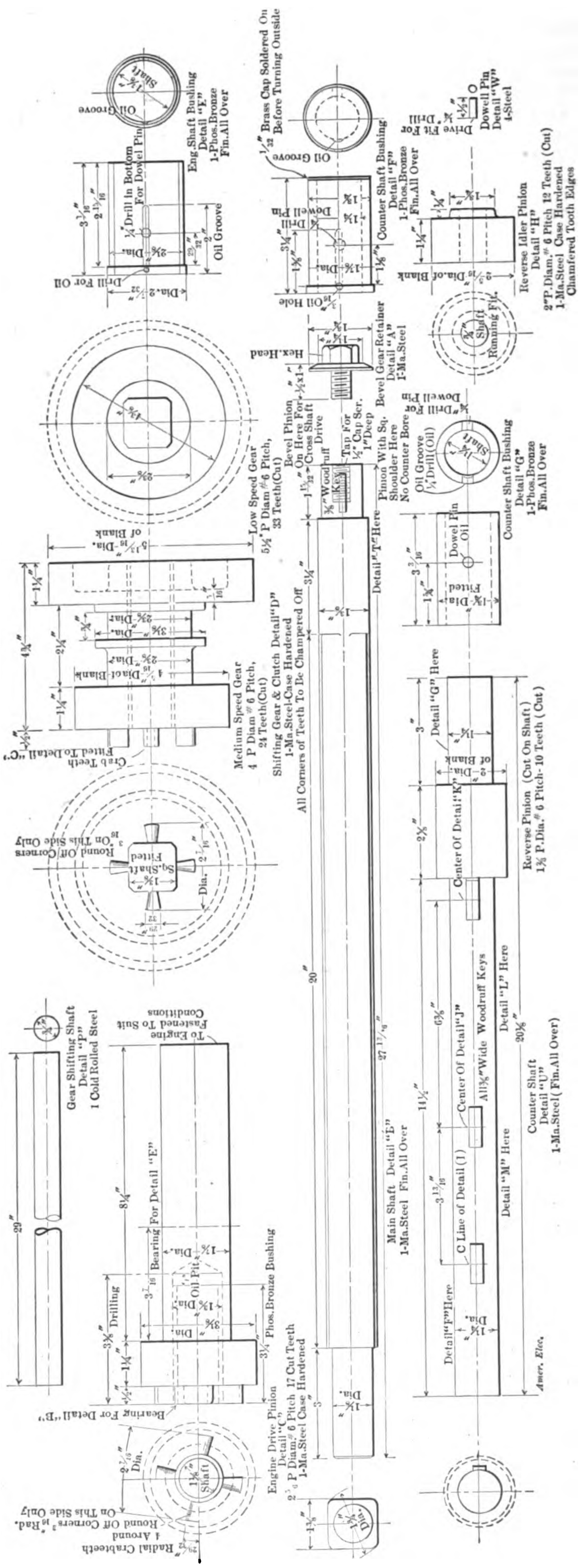
Eng. Shaft Bushing Detail "E" 1-Phos.Bronze Fin.All Over
Oil Groove
¼" Drill in Bottom For Dowel Pin
Drill For Oil
1/32" Brass Cap Soldered On Before Turning Outside
Counter Shaft Bushing Detail "F" 1-Phos.Bronze Fin.All Over
Dowel Pin
Dowel Pin Detail "W" 4-Steel
Drive Fit For ¼" Drill
Reverse Idler Pinion Detail "H" 2" P.Diam.# 6 Pitch 12 Teeth (Cut) 1-Ma.Steel Case Hardened Chamfered Tooth Edges
Shaft Running Fit
Hex.Head
Bevel Gear Retainer Detail "A" 1-Ma.Steel
Low Speed Gear 5½" P Diam.# 6 Pitch, 33 Teeth(Cut)
Bevel Pinion On Here For Cross Shaft Drive
Woodruff Key
Tap For ½" Cap Scr. 1" Deep
Pinion With Sq. Shoulder Here No Counter Bore
Oil Groove
Oil Hole
Counter Shaft Bushing Detail "G" 1-Phos.Bronze Fin.All Over
Medium Speed Gear 4" P Diam.# 6 Pitch, 24 Teeth(Cut)
Shifting Gear & Clutch Detail "D" 1-Ma.Steel-Case Hardened All Corners of Teeth To Be Chamfered Off
Detail "T" Here
Crab Teeth Fitted To Detail "C"
Round Off Corners On This Side Only
Sq. Shaft Fitted
Reverse Pinion (Cut On Shaft) 1⅔ P.Dia.# 6 Pitch-10 Teeth (Cut)
Detail "G" Here
Center Of Detail "K"
Gear Shifting Shaft Detail "P" 1 Cold Rolled Steel
To Engine Fastened To Suit Conditions
Bearing For Detail "E"
Drilling
Oil Pit
Main Shaft Detail "E" 1-Ma.Steel Fin.All Over
Center Of Detail "J"
All ⅜" Wide Woodruff Keys
Detail "L" Here
Detail "M" Here
C Line of Detail (I)
Detail "F" Here
Counter Shaft Detail "U" 1-Ma.Steel (Fin.All Over)
Engine Drive Pinion Detail "C" P Diam.# 6 Pitch 17 Cut Teeth 1-Ma.Steel Case Hardened
Phos.Bronze Bushing
Bearing For Detail "B"
Radial Crabteeth 4 Around
Round Off Corners Rad. On This Side Only
Shaft
Amer. Elec.

FIG. 4.—CHANGE SPEED GEAR DETAILS.

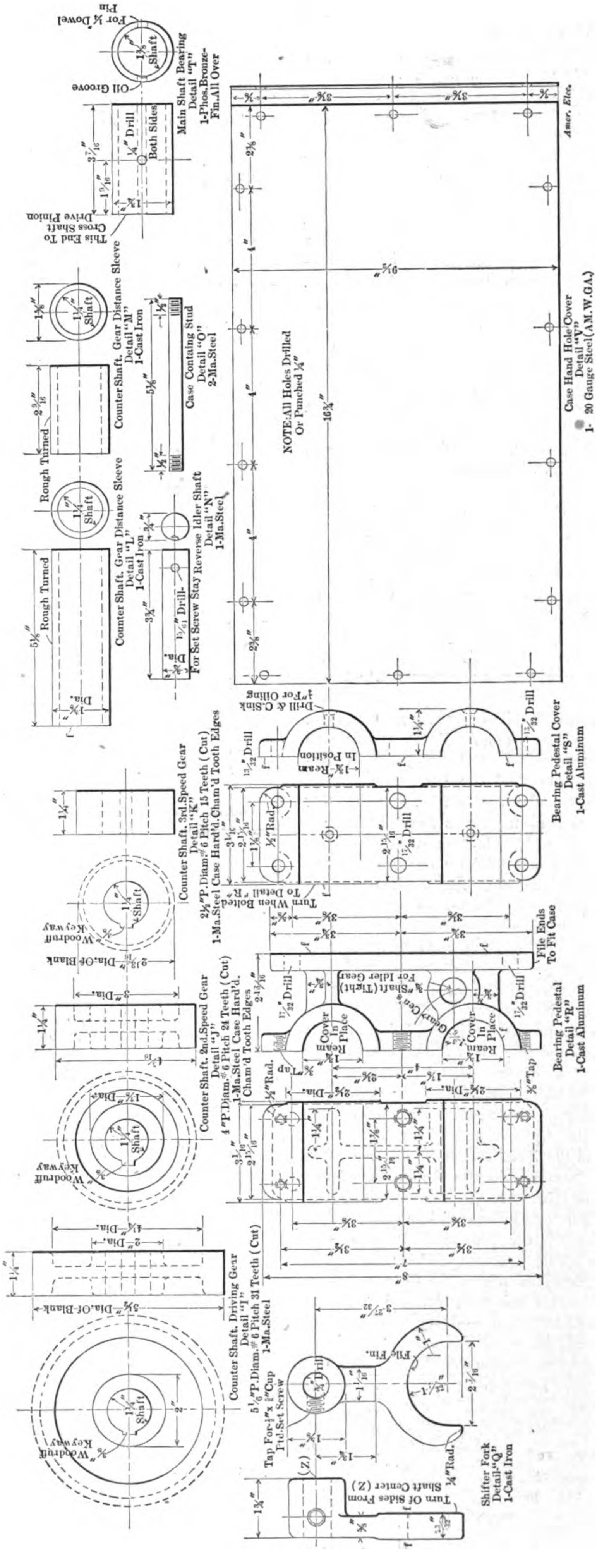
Main Shaft Bearing Detail "T" 1-Phos.Bronze-Fin.All Over
Oil Groove
For ⅛ Dowel Pin
This End To Cross Shaft Drive Pinion
Both Sides
Counter Shaft. Gear Distance Sleeve Detail "M" 1-Cast Iron
Case Containg Stud Detail "O" 2-Ma.Steel
Counter Shaft. Gear Distance Sleeve Detail "L" 1-Cast Iron
For Set Screw Stay Reverse Idler Shaft Detail "N" 1-Ma.Steel
Rough Turned
NOTE: All Holes Drilled Or Punched ¼"
Case Hand Hole Cover Detail "V" 1- 20 Gauge Steel(AM.W.GA.)
Amer. Elec.
Counter Shaft. 3rd.Speed Gear Detail "K" 2¾"P.Diam.#6 Pitch 15 Teeth (Cut) 1-Ma.Steel Case Hard'd.Cham'd Tooth Edges
Drill & C.Sink ¼" For Oiling
In Position
Turn When Bolted To Detail "R"
Bearing Pedestal Cover Detail "S" 1-Cast Aluminum
Counter Shaft. 2nd.Speed Gear Detail "J" 4"P.Diam.#6 Pitch 24 Teeth (Cut) 1-Ma.Steel Case Hard'd. Cham'd Tooth Edges
Woodruff Keyway
Dia. Of Blank
Shaft
File Ends To Fit Case
Shaft(Tight) For Idler Gear
Cover In Place
Ream
Bearing Pedestal Detail "R" 1-Cast Aluminum
Counter Shaft. Driving Gear Detail "I" 5¼"P.Diam.#6 Pitch 31 Teeth (Cut) 1-Ma.Steel
Tap For-¼"x ⅜"Cup Pt'd.Set Screw
Fin.
Turn Of Sides From Shaft Center (Z)
Shifter Fork Detail "Q" 1-Cast Iron

FIG. 5.—CHANGE SPEED GEAR DETAILS.

over the shaft, as no lateral thrust is to be withstood.

For the keying of the stationary gears the Woodruff system has been specified throughout, and though taper flat keys can be employed successfully at the hands of careful workmen, the other arrangement is more readily and cheaply applied when the proper facilities are at hand, and it has in general practice given more reliable results.

The differential or compensating gear on the cross shaft shown in position in connection with the bevel gears in Fig. 1, was originally specified to be the Brown-Lipe No. 8. Any other of the standard makes, of a size capable of transmitting this power, may, however, be used without change of details. Manufacturers of differential gears furnish the bevel gears complete with side bearings to fit either in the rough or finished, so that with the dimensions of the case supplied them no trouble should be experienced. These outfits as supplied by the markets to-day are recognized standards and no attempt has been here made to supply a special design, which at best would be an added complication exacting the best of workmanship with no possible gain in economy.

Having proceeded with the work to the time of application, everything should be carefully inspected to see that no dirt or chips have got into any of the teeth of the gears or around any of the bearings and interspaces. The lubricant, composed of about equal parts of a good machine oil and a solid grease, may now be put into the case through the hand inspection hole and should fill the case about half way, or to the shaft lines, although a half of this amount increased up to a two-thirds filling of the case is entirely permissible for good results.

To operate the change speed gear on the vehicle means are, of course, necessary for moving the shifter rod from the operator's seat. This is accomplished, preferably, through a side lever fulcrum shaft, radius levers, rods and connections terminating at the shifter rod of the change speed gear.

◆◆◆

Windmills for Driving Electric Generators.—An example of the use of the windmill for generating electricity is provided by the village of Askow, in Denmark. The windmill can be supplemented by a small oil engine in case of a period of quiet weather. There is storage capacity for four or five days, so the engine is seldom required—only about thirty days every year. From this station the village is supplied with light, and power is provided for industrial and agricultural purposes. Growing use is also being made of windmills in the West for generating electricity in connection with agriculture. The question of utilizing the wind for driving farm machines is of great importance to farmers in those regions, as there are no large streams for them to harness. Several windmills are worked together on some farms to operate the generators, and in this way 10 horsepower motors are working in the field continually.

TAKING UP LOST MOTION.

BY WALTER W. EDWARDS.

No matter how well built an engine may be, or how carefully run, it is sooner or later necessary to take up the wear at various bearings. The method of procedure necessarily varies, depending on the bearing to be adjusted, and also upon its size.

The object of taking up the wear on a bearing is to make it so tight that it will not pound, and yet sufficiently loose so that there is no undue friction to cause heat. Pounding and heating are the limits, so to speak, between which an engineer must work, and various expedients are used to determine, without actually running the engine, whether or not either limit has been exceeded.

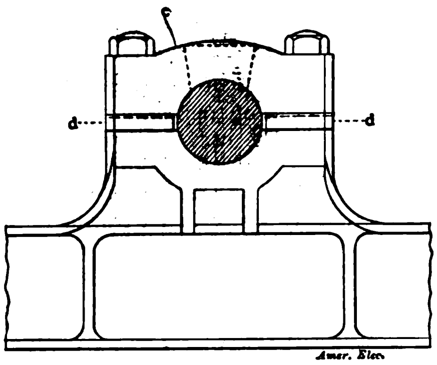

FIG. I.

One of the best methods of testing the adjustments of bearings is to take leads from it and measure their thickness after the cap of the bearing has been set up tight on the distance pieces and liners on either side. To apply this method to a bearing such as shown in Fig. 1, the cap *c* is removed, leaving the journal bare as shown in Fig. 2. Pieces of lead wire are then laid across the journal as shown at *aa* in Fig. 2. In choosing wire for this purpose, care should be exercised in obtaining lead which is quite soft. Wire that is made of pure lead is very good, as are also many grades of fuse wire used in electrical work. There are some grades of fuse wire, however, which are altogether too hard for the purpose, and these should be carefully avoided. The wire should be about No. 22 gauge, and at lease two pieces should be used, and sometimes three, if the bearing is a very large one. When these wires are laid across the bearing as shown in Fig. 2, the cap *c* should be replaced and the nuts on the studs set up as tightly as possible. In the close quarters usually found around engine bearings, it is best to use a wrench with a short handle, striking the handle of the wrench with a light sledge. When the nuts are set up as tightly as they will go, without using undue force on them, their positions should be marked lightly by means of a center punch so that it will be possible subsequently to return them to their positions.

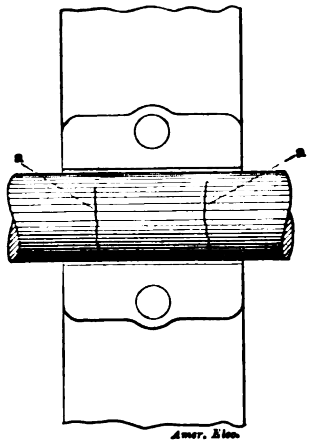

FIG. 2.

The nuts may then be unscrewed, the cap lifted off, and the wires removed. They will be found to be crushed into thin lead ribbons, the thickness of which is a measure of the amount of play between the journal and brass. The lead ribbons should be measured by means of a wire gauge. If the shaft is large, say 12 inches or more in diameter, and the engine does not run more than 120 revolutions per minute, the leads may have a thickness of 28 to 30 gauge. If the shaft is smaller and the number of revolutions greater, the thickness of the ribbons should not be less than 32, and may run as high as 34. The writer has taken leads of No. 35 gauge on bearings which had not given any trouble, but the practice is not recommended, especially on an engine with which the engineer is not thoroughly familiar.

The leads should be carefully examined, and the gauge tried at different points to determine whether or not they are of uniform thickness. If they are thicker near the ends than at the middle, it is evident that the brasses are not as close at the sides as they are at the bottom of the brasses. This is as it should be, since brasses that are close at the sides increase the friction without materially increasing the surface that is effective in transmitting energy. This point will be made clear by an inspection of Fig. 3. The direction of the application of force to the brass may be represented by the arrow. The effective area may be found by projecting the bearing surface in the line *ab*. If the rubbing surface of the brasses is cut away by an amount equal to one-quarter on each side, the friction has been reduced proportionately, and the effective area reduced from *ab* to *cd*. If the leads are thinner at the sides than in the middle, the babbitt or brass should be cut away at the sides. If the leads are uniformly too thick, a liner should be taken out at each side to allow the brasses to come closer together. These liners are always placed on top of the distance pieces *dd*, Fig. 1, for this purpose, and when all the liners have been removed through successive adjustments, the distance pieces should be planed thinner.

A word of caution is necessary in regard to this method and its application A bearing may give very good leads and the brasses still have high places between the leads, which cause heating at these points, although where the leads were placed the brasses were very accurately adjusted. Until an engineer has become thoroughly familiar with his engine and is reasonably sure that no high places exist, he should not take as thin leads as he might later. There is, perhaps, no other one thing about engine management that requires as much good judgment as the adjustment of bearings.

There are other methods by which brasses, such as crank-pin brasses or those on the wrist-pin, may be adjusted, but as they are comparatively simple, an extended description is not needed. One widely used method is to key the brasses on the pin as tightly as possible, and then loosen the key or nuts as the case may be, until sufficient lost motion is provided. The amount of looseness depends on the size and speed of the engine and also upon the taper of the gib and key, or the pitch of the threads on the bolts. This method depends for its success almost wholly on the experience and judgment of the engineer. It is also open to the objection that the loosening process may leave the liners between the brasses so loose that there is danger of their flying out when the engine is running. If dowel pins are fitted, they would, of course, prevent this.

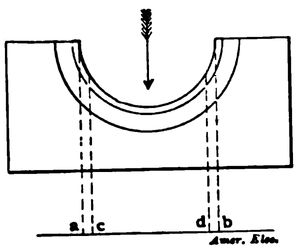

FIG. 3.

Another method of determining the amount of lost motion to be allowed in connecting-rod brasses is to set the brasses up as tightly as it seems probable that they will run, and then test the work by using a bar or other means of moving the end of the rod from side to side on the pin. In large engines there is always sufficient lateral motion possible to test the adjustment of the brasses. If they are moved with difficulty from side to side it is plain that they are set up too tightly, while on the other hand, if they are moved too easily, it is probable that they can stand more tightening. The great advantage that this method has is that it requires but little time to apply it.

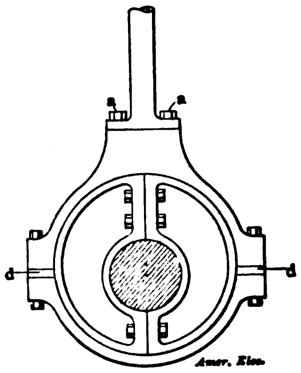

FIG. 4.

Other bearings often permit other methods of adjustment. In the case of an eccentric strap such as shown in Fig. 4, it is better to take up the lost motion by disconnecting the eccentric rod by the removal of the tap bolts *aa*. It is then possible to turn the eccentric strap by hand and if found too loose, the nuts at the side may be unscrewed and liners removed from the distance pieces *dd*. If there are no liners there, the distance pieces should be made thinner, and liners introduced. If there are no distance pieces the straps themselves must be cut away. The object of introducing distance pieces such as are shown by Fig. 4, is to facilitate this operation. The light distance pieces are easier handled in the machine shop than the whole strap.

In adjusting bearings by taking up the lost motion, care must be exercised not to change the length of any of the reciprocating parts. If, for instance, the wear in the connecting-rod brasses were continually taken up by the removal of liners, the length of the rod from center to center of the brasses would be shortened, and eventually the piston would strike the crank end of the cylinder. This can be guarded against by disconnecting at the crosshead, and then moving the piston as far as it will go in either direction. The extreme positions of the crosshead should be marked on the guides. These marks are called the striking points, and it should be the purpose of the engineer to keep the path of the crosshead as near central between these marks as possible. The length of the connecting-rod can be varied by putting liners back of the inner brasses at either end of the rod.

◆

CALIBRATION OF RECORDING WATTMETERS.

BY GEO. T. HANCHETT.

There is perhaps no electrical instrument over the accuracy of which controversy is as likely to arise as over that of the recording wattmeter. The principal reason for this is obvious: the inaccuracy of such a meter affects the pockets of all concerned. As a matter of fact, a recording wattmeter cannot be expected to register closer than 2 per cent except by great good fortune, and any controversy over a matter of that magnitude is an idle one for the reason that when the meter is checked again to verify statements, the result is likely to be as much in error on the other side of accuracy.

There are several convenient ways of testing a meter. The most primitive of these, but one of the most convenient, is to burn a known number of lamps for an hour, reading the meter before and after the test. The 3½-watt, 16-c.p. lamp consumes about 56 watts, and if ten lamps are burned for an hour the meter should indicate approximately 560 watt-hours. Any gross error, such as one of 30 or 40 per cent, can be detected in this way.

For closer work tests can be made in several different ways. These are divided into two classes. One is known as the revolution method and the other is the test by dial reading. The revolution method always involves the timing of the revolutions of the meter disc and the computation of the energy that is being recorded by the employment of suitable constants. The method of dial reading consists in passing through the meter a quantity of electrical power and comparing this measured quantity, multiplied by the time, with the indications of the dials. This is sometimes the only resource when the cover of the instrument cannot be removed and the revolving disc is not otherwise visible.

The usual plan in calibrating by dial indications is to run the meter under a suitable load, preferably about the average load that is used on the meter in practice, and to note the time required for the first dial hand to make one complete revolution. The electrical power is measured by a portable indicating meter inserted in circuit with the meter to be tested and read at five-minute intervals, the general average being taken, and the power thus measured being multiplied by the time. In alternating-current work the standard instrument should be a portable wattmeter, for in such cases the product of the ammeter and voltmeter readings will not be the true power.

Another method is to put in circuit with the recording wattmeter a second recording wattmeter of known accuracy and to allow them both to run for twenty-four hours. This makes a test on a complete cycle of loads and the readings of the two meters can be compared directly. The standard meter, however, requires constant attention and for close work should be calibrated before and after the test. It has the advantage that it measures true watts on an alternating-current circuit.

The revolution method is the one employed most frequently, and consists in measuring the power and simultaneously timing the revolutions of the disc. The power passing through the wattmeter is proportional to the speed of the disc and can be accurately represented by the speed of the disc multiplied by a certain number, which is called the disc constant. This constant varies with the different makes of meter because of the flexibility of the units that may be chosen. The general equation is

$$\textit{Kilowatts} = S\,K,$$

where S is the speed and K is a constant.

It is plain that if S is the speed in revolutions per minute, the constant will have one-sixtieth of the value that it would have if S were revolutions per second, and similarly, if the power were expressed in watts instead of kilowatts, this would increase the constant 1000-fold. A common form of constant, which is much used with Thomson recording wattmeters, is that number by which the revolutions made in one hour must be multiplied in order to give the watts passing through the instrument. In testing an instrument which has such a constant, it is usually most convenient to take the time that the disc requires to make ten revolutions, which can be done to within two-tenths of a second by means of a stop watch. Taking a practical case, suppose that an instrument has a calibrating constant of 2, and that the test load is such that the disc makes ten revolutions in 70 seconds. The power passing through the instrument is equal to

$$\frac{10 \times 3600 \times 2}{70} = 1028.6 \textit{ watts}.$$

This should be compared with the power measured simultaneously by accurately calibrated indicating instruments. If the computed power is greater than the measured power, the disc should be made to travel more slowly by adjusting its magnets, and conversely.

The constant of the meter should not be confused with the constant of the dial mechanism, which is usually printed thereon, and which may be a totally different figure, because of the gear ratio selected. When the first dial, indicating 1 kilowatt-hour per revolution, makes one turn to 1000 of the disc, then the constant of the meter is the same as the constant of the disc, but when the gear ratio differs from this a proportionate number is introduced which alters the constant of the meter. Thus, when a disc constant is 1.25 and the ratio between disc and dial motions is 1000, then the constant of the meter is also 1.25. If, however, it is desired to have the meter read directly, it will be necessary that the dial hand make one revolution to 800 of the disc, which could be done by selecting a proper gear ratio.

If the constant of the disc is not given, it is always possible to determine it by noting the ratio between the disc and the dial reading kilowatt-hours. The constant in this case is that number by which the revolutions per hour must be multiplied in order to give the power in watts. Assume 1 kilowatt to be flowing through the instrument. Then in one hour the kilowatt-hour hand should make one revolution, and the disc will make a certain number of revolutions, which, when multiplied by the constant, equals 1000. Consequently, the constant equals 1000 divided by the ratio between the rate of disc revolutions and that of the kilowatt-hour pointer; that is,

$$K = \frac{1000}{\textit{ratio}}.$$

Another way in which the constant may be expressed is as the time in which the disc will make as many revolutions as there are watts flowing through the instrument, as

$$\textit{watts} = S\,K,$$

where S is the revolutions per hour, then the time, t, in hours has the following relation to the constant, K:

$$t\,S = \textit{watts} = S\,K;$$

that is to say, $t = K$, so that in K hours the number of disc revolutions would equal the watts flowing through the instrument. It is sometimes convenient to reduce the time to seconds and the watts to kilowatts, when the relation becomes

$$t'' = 3.6\;K,$$

t'' being the time in seconds required for the disc revolutions to equal the kilowatts. Thus, if a meter had a disc constant of 2, it would in 7.2 seconds make as many revolutions as kilowatts, and if the disc constant were ½, it would do this in 1.8 seconds. In some cases it would be very inconvenient to time the disc for so short a period, so the constant is multiplied by 100 and the resulting revolutions are correspondingly divided. Thus the constants, 360 and 180, would indicate six and three minutes, respectively.

The errors to which a recording wattmeter may be subject are principally those of friction. There is, of course, a possibility of change in the magnetism of the retarding magnets or of the resistance of the potential circuit of the instrument, but these are insignificant compared with the friction error. The principal friction of the instrument is that of the commutator and brushes. Next to that comes the friction of the bearings, and lastly the friction of the recording mechanism. The latter is so small as to be practically negligible, and a recording wattmeter in good order will give substantially the same readings when tested by the rotation method whether the recording mechanism is in place or not. By far the most important item is the friction of the brushes, and its importance will readily be recognized when it is observed how the slightest tampering with them affects the accuracy of the instrument. Friction of the jewels is, like the friction of the mechanism, very small.

Because of the friction of the brushes, etc., when a meter is at rest a certain definite amount of current must flow through the series winding before it will start. This may be of such magnitude that at the full line voltage the starting power may amount to as much as 60 or 70 watts—ample for one 16-c.p. lamp. As soon as the meter is once started, the amount of current necessary to keep it in motion is considerably less, perhaps only one-half as much as the starting current. After the armature once starts, the retardation due to friction is roughly a constant quantity and on very light loads is a source of large percentage of error; on very heavy loads it is of less importance. It is a common plan to provide in such instruments an additional independent source of torque, which shall be constant and will balance the friction torque. This is done by inserting in series with the meter armature a field coil which is adjusted in its position with relation to the armature until sufficient torque is obtained to compensate for the retarding effect of friction. This is best obtained by adjusting the coil so that the armature will start on no load and then gradually moving the coil so as to reduce its influence on the armature until the disc stops.

It must not be forgotten that the torque due to the starting coil is proportional to the square of the applied voltage. If, for instance, an instrument were designed to work on a system of 110 volts, the torque of the starting coil would be proportional to the number 12,100. If the system were changed and the voltage raised to 120 volts, the torque would be proportional to the number 14,400, or 20 per cent greater than before. Therefore, it is very important that the meter be operated at the voltage for which it is intended.

The errors due to friction and due to the magnets are almost always such as to make the meter run slow. Artificially aged magnets frequently show a tendency to strengthen, and friction of any kind always increases with age. Hence, the usual trouble with the meter is that it records too little rather than too much.

In testing a meter for very close work, it is important to note whether the delivered watts or the supplied watts are compared with the recorded readings of the meter. In commercial work the meter is intended to record the delivered watt-hours. Hence, in connecting standard instruments to the meter circuit for the purpose of checking its record, the series or current connections, whether for an ammeter or a wattmeter, should be on the house side of the meter in order that the current of the potential coils of the meter may not be included in the reading of the delivered power. The voltmeter or potential connections should be made on the line side of the meter in order that the recording wattmeter may not measure the energy of the potential circuit, of which no account is taken by the calibrating instruments. The drop through the series coils of the meter is usually so small that it can be neglected.

In testing three-wire meters, several quite important precautions should be taken. The meter is supposed to be correct on a balanced load. If the load becomes unbalanced, the magnetic effect of the field upon the armature is not so effective as if it were balanced, and the meter runs slow. One expedient is to balance the load accurately and remove the neutral fuse, in which case the meter is tested as an ordinary 220-volt, two-wire meter. This is not always a safe procedure, because, unless the system is under absolute control, some one is likely to upset the balance during the test and endanger the lamps.

Another plan is to install two shunts, one in each leg of the three-wire system, and transfer a millivoltmeter from side to side, or, better still, to have two millivoltmeters. A convenient blank form for testing meters by the dial method is as appears below:

Date..................

Test of meter located at John Jones', No. 10 Gamewell St.

Meter Data From Name Plate.

Type M. Volts, 240. Amperes, 15. Three-wire. Constant, 2. Manufacturer's No., 102,571. Company's No., 3,279. Measures electricity for —— Lights.

Time.	Meter reading.	V.+	Amp.+	V.—	Amp.—
1	2,352,700	120	10	120	13
1.05		120	10.1	120	13.2
1.10		121	10	119	13.7
1.15		120	10.2	119	12
1.20		119	10	121	13
1.25		120	10.3	120	12.2
1.30		121	10	120	10.5
1.35		120	9.9	121	10.5
1.40		119	9.9	119	13.2
1.45		119	10	119	13
1.50	2,353,800				
Difference	1,100				
	Totals	1199	100.4	1198	124.3
	Averages	119.9	10.04	119.8	12.43
Corrected	averages	119.2	10.54	119.2	12.93

Watts+ $119.2 \times 10.54 = 1256$

Watts— $119.2 \times 12.93 = 1542$

Total watts 2798

Elapsed time 50 minutes

Kw.-hrs. by instrument $= \dfrac{2798 \times 50}{60 \times 1000} = 2.332$

Kw.-hrs. by meter $1.100 \times 2 = 2.200$

Percentage of accuracy $= \dfrac{2.200}{2.332} \times 100 = 94.3$

Error 5.7% slow

For a disc test the following form may be advantageously used:

Date..................

Test of meter located at 10 Gamewell St.

Meter Data from Name Plate.

Type M. Volts, 240. Amperes, 15. Two wire. Constant, 1. Manufacturer's No., 21,749. Company's No., 1,273. Measures power to — pump. Disc constant, 1.25.

Results of Test.

Time of 10 revolutions 63 seconds

Volts 240 Corrected, 239

Amperes 2.9 Corrected, 2.85

Watts by standard instruments 682

Watts by meter $\dfrac{3600 \times 1.25 \times 10}{63} = 715.0$

Percentage of accuracy $\dfrac{715}{682} \times 100 = 104.8$

Error 4.8% fast

It may be well to add in closing that meter testing is always a matter over which controversy is likely to arise, perhaps lawsuits, and consequently any one who tests meters should be very sure of the accuracy of his instruments, calibrating them both before and after the test.

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FIRE ALARM CIRCUITS.

BY SIDNEY DIAMANT.

As in all cases which involve distribution of circuits over an extensive area, the circuits, etc., in a fire alarm system are controlled fundamentally from a main or central station. Fig. 1 is a general plan for two complete sets of circuits, showing the central station, fire houses and fire alarm boxes. In a large city wherein congested districts necessitate the prompt sending of an alarm, there may be hundreds of such circuits. The cycle of operation of the fire alarm circuits and the manner of immediately having the apparatus dispatched to the scene of fire is explained by aid of the general plan and three detailed diagrams.

The fire alarm is turned in by means of a fire box, the circuits of which are represented in Fig. 2. The small T handle which appears on the outside of the box is turned to the right and at the same time pulled toward the operator so as to force open the outer door when the latch is released by the turning mechanism. The turning of this handle is accompanied by the loud ringing of a bell which in no way has any connection with the alarm circuit, but is merely intended to frighten off a meddler. While this may generally be regarded as an advantage, yet trouble often arises due to the frequent misinterpretation by ignorant persons of this bell for the main alarm; and so the signal does not reach the central station. However, a fairly intelligent person who assumes the responsibility of turning in an alarm, will read on the inner door of the box, "Pull down lever and let go." When the hand lever, shown in Fig. 2, is pulled down against the action of the actuating spring, the rack is lifted upward. During this movement of the rack, there is no contact between it and the large pinion, but when the hand lever is released, the actuating spring sets the mechanism in operation by engagement between the large pinion and the rack during the descent of the latter, properly guided. Because of the ratio between the diameters of the two pinions, the smaller one makes four revolutions during the complete travel of the rack. Therefore the star wheel to which the small pinion is rigidly connected, sends in four complete and identical alarms.

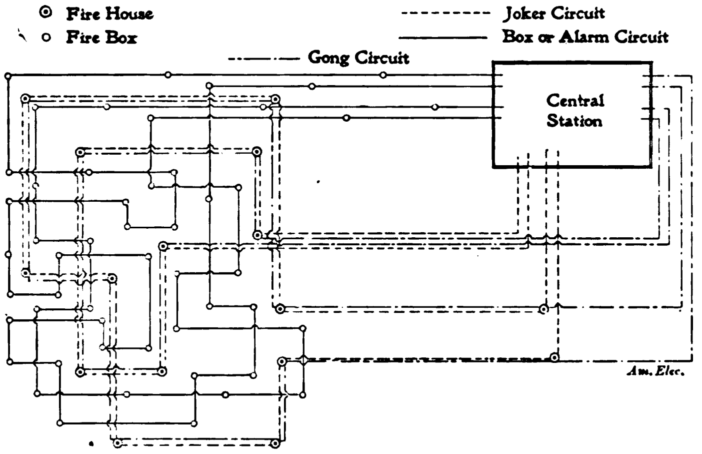

FIG. 1.—PLAN FOR TWO SETS OF CIRCUITS.

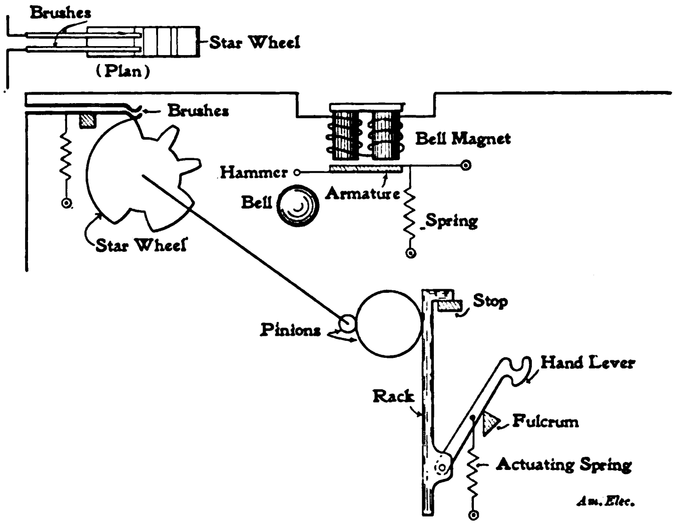

FIG. 2.—FIRE BOX CONNECTIONS.

Under normal conditions, when the circuits are not in operation, the two brushes touch the metallic star wheel, thus permitting the current, which is comparatively small, to flow continuously. An insulating stop acts as a rest for the brushes when they are not in contact with the star wheel, but over a space between the teeth. During the transmission of the alarm the star wheel rotates in a direction such that the spaces between the teeth indicate the number of the call by successively coming under the brush ends. When the brush ends are over a space, the current is interrupted and the bell magnet, which is in series with the line, is de-energized, allowing the spring to pull the hammer against the small bell. Under normal or "no alarm" conditions, the elastic force of the spring is overcome by the magnet which is then energized by the current flowing through its windings. Thus each time the ends of the brush are opposite a gap between the teeth of the star wheel, the hammer strikes the bell once. The star wheel in the diagram has three indentations at equal intervals separated by short periods of contact, then a longer period of brush contact, then a single indentation or space, followed by a long period of contact, before the alarm is repeated. This star wheel put into operation would result in the transmission of four alarms corresponding to box 31. As the sender hears the alarm being rung off at the box, the central station is simultaneously receiving the signal.

Fig. 3 illustrates diagrammatically the arrangement of circuits at the central station. During each interruption of the main circuit, previously considered, the relay magnet *RM* loses its magnetism and the armature is drawn by a spring against the contact *C*, closing the local battery circuit. Each time this local circuit is closed, the bell *B* receives an impulse and at the same time the recorder magnet *Rc M* records the alarm either by punching holes in the tape *T*, or by means of a stylus recording with ink. In either case the record is effected mechanically by the appropriate movement of an arm attached to the armature of the recording magnet *Rc M*. As soon as the first round of the alarm is received, it is sent out on the "joker" circuits to every fire house and to the Board of Fire Underwriters by the person to whom this duty is assigned. Upon proper assurance of the accuracy of the alarm by the receipt of three or four rounds, the signal is sent out on such gong circuits as will result in the most prompt response from the fire house nearest the location of the fire.

The operation of the gong alarm is accomplished by a suitable star wheel, shown in Fig. 3, which depends for its action upon mechanism similar to that in the fire box already described. At the central station there is systemmatically arranged on boards a number of these star wheels, each one of which is intended to duplicate the alarm received from a particular fire box. Fig. 4 illustrates the general arrangements by means of which the alarm is received at the fire house. The joker bells are operated on an open circuit system so that the depression of the sending key by the operator energizes the joker magnet *JM*. Its armature is attracted against the force of the spring and the hammer strikes the bell. This signal is intended only for the man at the desk, as it would not be judicious to awaken the firemen in the night if their services were not immediately necessitated by the existence of a nearby fire; the joker bell and magnet, therefore, are relatively small.

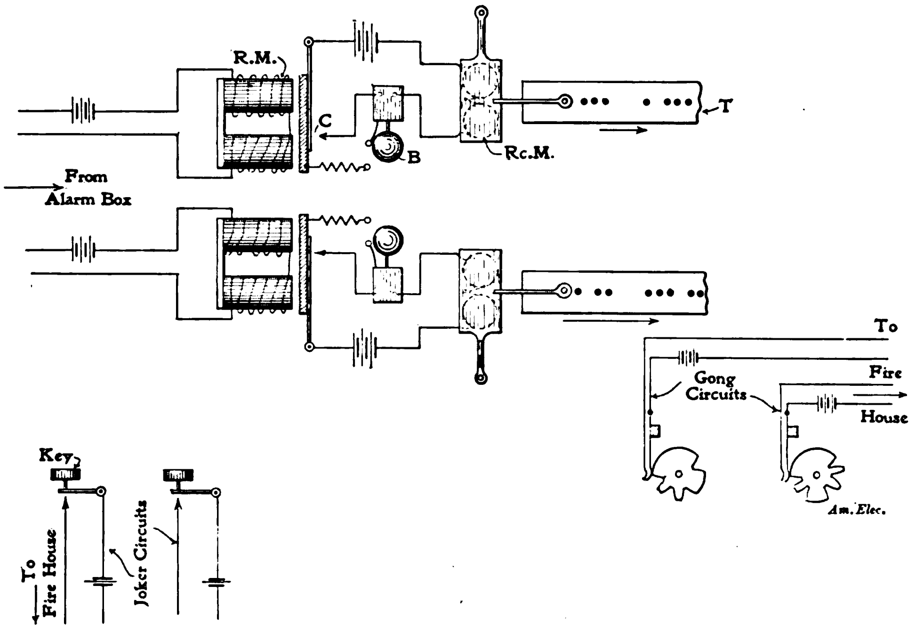

FIG. 3.—CENTRAL STATION CIRCUITS.

When the desk man at the fire house receives this signal he records it, and if it does not correspond to a box in the district no further attention is given to the matter, except that the horses, which by this time have taken their positions under the harness drops, are sent back to their stalls. If, however, the alarm is from a box in the district, the desk man gives the signal arousing his men. The apparatus is in readiness, and after assurance by a few rounds of the alarm on the joker circuit, the crew and apparatus leave for the fire. Only in event of a confusion of the joker signal does the crew wait for the gong alarm, which, in the case of good condition of the circuits, is generally heard at the fire house either concurrent with the departure of the apparatus or soon after. The gong circuit is operated by the star wheel at the central station exactly as the receiving apparatus there is operated by the star wheel in the fire alarm box. The gong gives a very loud alarm.

In case of the existence of a fire which promises to cause more than ordinary damage if not properly checked, special telephonic orders are given to have the apparatus advanced from one fire house to the other toward the fire, so that when a second alarm is given, the fire house nearest the fire always has apparatus for immediate response. In this way apparatus several miles away from the fire is gradually moved toward it, the advance depending upon the number of alarms given, so that there is centered about the troubled district sufficient means to promptly meet the demand for additional service.

As the diagrams clearly show, the primary operation of the alarm system is on the closed circuit plan, while the secondary or signal part of the cycle is through local circuits normally open and controlled by relay magnets in the main line. The most important advantage afforded by this method is the promptness with which trouble in the circuits makes itself apparent. If a break occurs on the line, the local circuit at the central station is closed by this interruption, causing the small bell *B* (Fig. 3) to ring continuously, calling attention to the circuit that is out of order. In case of a dead ground, the greater part of the current flows through the earth so that the current in the main line is considerably weakened; as in the case of an open circuit, the relay magnet at the central station closes the local circuit, indicating trouble by continuous ringing of the bell *B*. If, however, there exists only slight or temporary trouble which is not sufficient to disturb the operation of the system, the main magnets are not sufficiently demagnetized to allow notice to be given at the central station. So long as the system is not rendered inoperative no trouble is announced. Another advantage of the closed circuit system is that it does not depend upon large current strength for its operation, but upon the interruption of a comparatively small current. This advantage should offset the slight disadvantage of continuously using the current under "no alarm" conditions. Moreover, the current is so very small that the expense for its maintenance is not important.

In some cities the manual method of operating the joker and gong circuits is replaced by automatic machinery. A non-interference feature is also introduced which prevents the confusion of two alarms which were sent almost simultaneously from different boxes. The arrangement allows that box which first received the impulse to send in its complete alarm to the central station, after which the box next put into operation sends in its alarm.

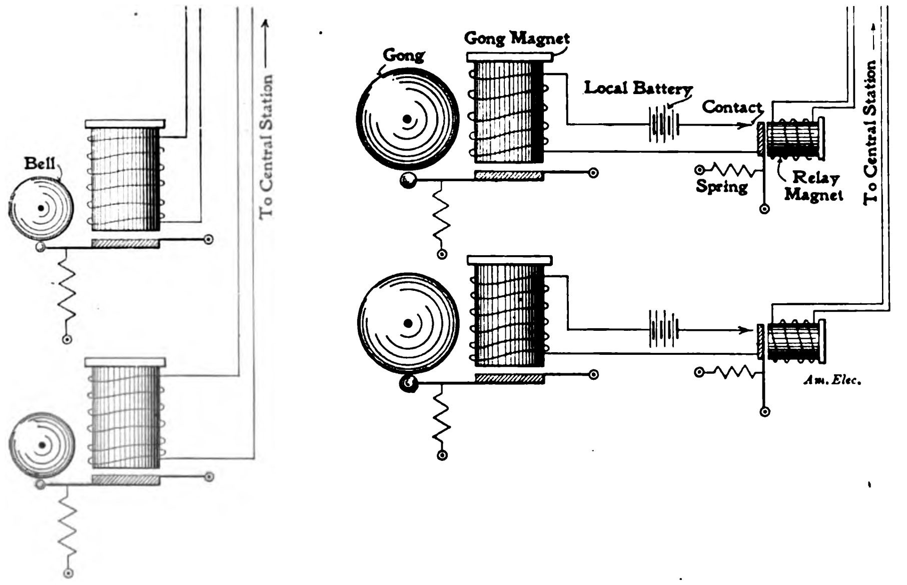

FIG. 4.—FIRE HOUSE CIRCUITS.

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SOME PRACTICAL POINTS FOR CENTRAL STATIONS.

One of the questions most frequently asked by those interested in the layout of central stations of moderate size is, "Which type of boiler is best suited to small stations, the water-tube or the ordinary horizontal return tubular boiler?" This question, as applied to a station of about 250 horse-power equipment, is answered in the Question Box of the National Electric Light Association in favor of the shell boiler by eleven practical electric light men and in favor of the water-tube boiler by eight others. The preponderance is obviously on the side of the shell boiler, and as the eleven advocates of it (for this size of plant) include some of the most prominent engineers in this line of work, it is fair to assume that the builder of a small station would do well to pin his faith to the old return-tubular shell type.

Another interesting topic is the relation between the boiler capacity of a station and its peak load. According to all but one of the opinions on this subject expressed in the Question Box, it is cheaper to operate a boiler plant of a capacity sufficient only for the average load and to use forced draft during the peak load than it is to use boilers of an aggregate capacity equal to the maximum peak load. The costs referred to are those of fuel and operation, presumably including depreciation and repairs.

As to the relative merits of the lever and pop safety valves, nine authorities declare in favor of the pop valve, while one points out that in a salty atmosphere the spring of the pop safety valve is likely to become weakened by rust. Gradually tightening the spring, he states, contracts the area of the relief passage, so that the valve may become dangerous in time.

The preference for 250-volt machines and auxiliary means for balancing a three-wire system, instead of 125-volt machines on each side of the neutral, which has several times been expressed in the editorial columns of this paper, is shared by all of those who have presented opinions on the subject in the Question Box, excepting one or two who entertain the erroneous idea that the large Edison stations use dynamos of half voltage to the exclusion of dynamos of overall voltage with balancers. In point of fact, the large Edison stations which have been built in recent years use either the latter arrangement or its equivalent, consisting of 250-volt rotary converters with compensating coils or a neutral connection tapped into the middle of the converter transformer windings.

Shunt-wound dynamos have been found preferable to compound-wound machines for lighting stations because of the greater simplicity of connection, ease of paralleling and dividing the load, and greater freedom from accidents due to "motoring." In railway or other stations where the load fluctuates violently and frequently, compound-wound machines are preferable because hand regulation is impractical.

In discussing the operation of compound-wound dynamos in parallel, several contributors to the Question Box have fallen into the common error of supposing that the compounding of each machine can be adjusted by means of a shunt strip across the terminals of its series field winding. Only three writers offered the correct advice to the effect that the compounding of each machine can be adjusted individually only by means of a resistance *in series* with its series field winding. When compound-wound dynamos are connected in parallel, all of the series windings are in parallel between the equalizer bus-bar and one of the main bus-bars; consequently a shunt strip in parallel with one of the windings is in parallel with all of them and affects all of them.

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Babbitt Metal for Motor Bearings.—The manager of a prominent interurban railway is using the following formula for making babbitt metal for motor bearings and states that it has given better results on heavy high-speed service than any other he has ever tried. The composition consists of forty-eight pounds of tin, four pounds of copper and one pound of antimony. The copper and tin are melted first and the antimony added afterward.

Lessons in Practical Electricity

TRANSFORMER LOSSES AND REGULATION.

As stated in last month's lesson, the ratio between the applied primary e.m.f. and the secondary terminal e.m.f. of a transformer is not always equal to the ratio of primary to secondary turns of wire around the core. When a load is put on the secondary circuit, the flow of current through the secondary winding tends to demagnetize the core, since it flows around the core in the contrary direction to that of the primary current. It does not demagnetize the core, however, because it is not in phase with the magnetizing current in the primary winding. But it shifts the phase of the primary induced e.m.f. so that it is less directly opposed to the applied e.m.f. and therefore allows more current to flow in the primary winding than when the secondary circuit was open. The result of this action is to produce changes in the primary current corresponding approximately to the changes in the secondary current, thereby making the transformer practically self-regulating when the primary is connected to a constant-potential circuit. The regulation cannot be perfect, however, on account of the internal losses. If the potential at the primary terminals be kept absolutely constant, the e.m.f. at the secondary terminals will be appreciably less when the secondary is fully loaded than when it is open; the difference is termed the "regulation" of the transformer. Thus, if the no-load secondary e.m.f. is 103 volts and the full-load e.m.f. 100 volts, there is a drop of 3 volts, and the regulation is 3 per cent (3 × 100 ÷ 100).

This difference of 3 per cent is caused by the drop in volts in the windings due to their resistance, the opposing effect of e.m.f.'s induced in the two windings by magnetic flux which leaks around between the windings instead of embracing both of them, and losses in the core which demand a certain amount of current in addition to that which is useful in the secondary circuit.

There are two classes of core losses: the loss by hysteresis or the tendency of the iron* to resist changes of magnetic condition, and the loss due to currents induced in the core by the alternating magnetic flux, and known as "eddy" currents. The loss by eddy currents is reduced to a relatively small proportion of the total losses by making the core of thin strips of metal instead of a solid block, and coating each strip with an insulating varnish so that the eddy currents cannot easily flow from plate to plate of the core. The benefit of thus dividing the core will be evident when it is considered that the eddy current loss is proportional to the *square* of the thickness of the core plates or strips.

The loss by hysteresis, according to Mr. C. P. Steinmetz, is proportional to the 1.6th power of the maximum magnetic density in the core. Thus, representing the maximum number of magnetic lines per square inch of core cross-section by B, the number of cycles per second by f, and the cubic inches of iron* in the core by v, the watts lost by hysteresis will be practically equal to

$$P_h = \frac{25\, B^{1.6}\, f\, v}{10{,}000{,}000{,}000}.$$

The thickness of the core strips does not affect this loss. The loss by eddy currents is practically equal to

$$P_e = \frac{43\, t^2\, f^2\, B^2\, v}{10{,}000{,}000{,}000},$$

so that the total core losses in watts are practically

$$P_c = \frac{v\,(25\, B^{1.6}\, f + 43\, B^2\, t^2\, f^2)}{10{,}000{,}000{,}000}.$$

Thus, with a maximum density of 40,000 lines per square inch, core strip of good quality 0.01 inch thick, and a frequency of 60 cycles per second, the core losses would be about 0.024 watt per cubic inch of core.

If the primary winding of a transformer be connected to a supply circuit of proper voltage and frequency and the secondary circuit be left open, a small current will flow in the primary. This is the "exciting" current, and consists of two components which are exactly one-quarter of a cycle displaced from each other in phase relation. One component, termed the magnetizing current, produces the magnetic flux in the core; the other is absorbed by the core losses just mentioned. The magnetizing current, which may be represented by I_m, is equal to

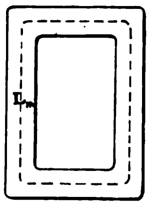
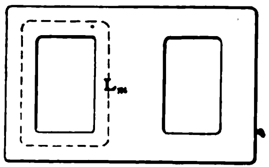


FIG. 1.



Amer. Elec.

FIG. 2.

$$\frac{k_m\, L_m}{N_t} = I_m,$$

in which k_m is the number of ampere-turns per inch of core length, L , that are required to produce 0.707 of the maximum magnetic density in the core. (The *effective* magnetic density = 0.707 × maximum density, and requires the same ampere-turns as a steady density equal to the effective density.) N_t is the number of turns of wire in the whole primary winding. The dotted lines in Figs. 1 and 2 indicate what is meant by the core length.

The core-loss current is equal to the core loss in watts divided by the primary induced e.m.f., with which it is exactly in phase. The induced e.m.f. is

$$E_i = 4.443\, \Phi\, N_t\, f \div 100{,}000{,}000,$$

Φ being the effective magnetic flux in the core, and f the cycles per second. The effective flux is equal to 0.707 × the maximum flux, and the maximum flux is equal to the maximum density multiplied by the core cross-section. Consequently,

$$E_i = 3.1416\, B\, A\, N_t\, f \div 100{,}000{,}000.$$

Dividing the watts of core loss by this gives the core-loss current, thus:

$$\frac{P_c}{E_i} = \frac{L_m\,(1.7\, t^2\, f\, B + B^{0.6})}{12.57\, N_t} = I_c$$

Since the core-loss current and the magnetizing current are one-quarter of a cycle apart in phase, the relation between them and the exciting or no-load primary current is the same as that between resistance, reactance and impedance; thus:

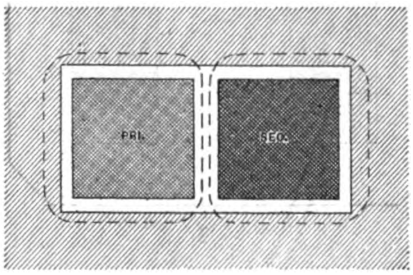


FIG. 3.

$$I_o = \sqrt{I_m^2 + I_c^2}.$$

The magnetizing current is usually much greater than the core-loss current, and since it is one-quarter of a cycle behind the primary induced e.m.f. in phase, the exciting current lags behind the induced e.m.f. almost a quarter of a cycle. The volts lost by the passage of this current through the primary winding, therefore, are not directly opposed to the applied e.m.f., and do not affect the regulation of the transformer very greatly.

Magnetic leakage may affect the regulation considerably. This leakage consists of magnetic lines which pass between the two windings, instead of encircling both of them, as indicated by the dotted lines in Fig. 3. The amount of leakage depends largely upon the type of transformer core and arrangement of the windings. There

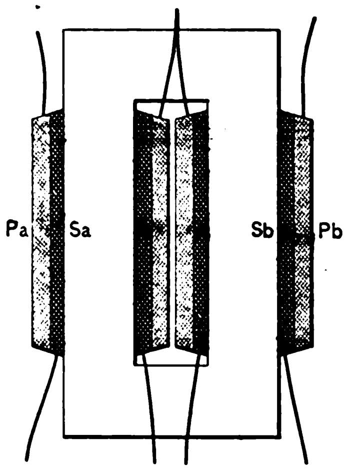


FIG. 4.

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*The material used in transformer cores is really annealed sheet steel.

are two general types of core; these are shown in Figs. 4 and 5. In the first type, the windings are divided into two sections, one located on each "leg" of the core; in Fig. 4 the primary sections are indicated by P_a and P_b, and the secondary sections by S_a and S_b. As this diagram indicates, the primary winding is usually put outside the secondary; the principal reason for this arrangement is that the voltage of the primary winding is very high and the winding requires to be more heavily insulated than the secondary.

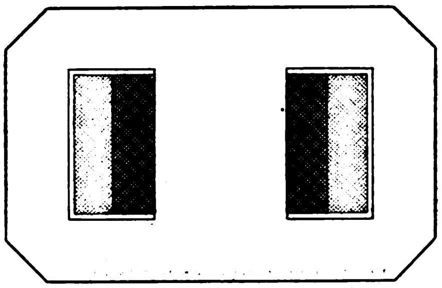

FIG. 5.

Transformers of the type represented in Fig. 5 are known as "shell" type. When the windings are arranged one over the other, the primary is on the outside, as in the case of the other type of core. Except when it is of importance to get as much radiating surface as possible for the secondary winding, this arrangement is preferable to the side-by-side arrangement indicated in Fig. 6 because it makes the leakage path between the windings longer than the latter disposition of coils. Comparing Figs. 5 and 6, for example, it will be found that the "seam" between the coils is nearly twice as long in the former as in the latter case, although the core holes or "windows" containing the coils are the same size in both. This longer seam reduces the leakage flux because the reluctance of the leakage path is greater.

The leakage flux induces in each winding a reactive e.m.f. which, while it is not squarely opposed to the active e.m.f.'s, does increase the drop in the windings and thereby impair the regulation. The drop in the windings due to their resistance usually affects the regulation more than any other one contributing effect, but the combined effects of core loss, magnetizing-current drop and magnetic leakage frequently equal the effect of resistance drop, and when the load is inductive, they may exceed it considerably, making the total drop much more than double the resistance drop alone.

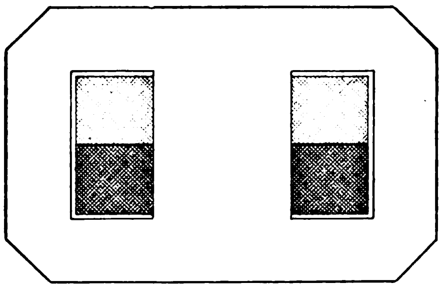

FIG. 6.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Flashing-Over of Rotary Converters.

To the Editor, American Electrician:

I should like to have some of your readers who are familiar with the operation of rotary converters inform me why these machines flash over at the direct-current end, and what the remedy is for that trouble. I am familiar with the care and operation of electrical machinery in general, and am alive to the necessity of keeping the commutator and brushes of any commutating machine clean and in good condition. This, however, does not seem to prevent flashing over.

Greenacres, Wash. B. E. Jerome.

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Mr. Maloney's Commutator Trouble.

To the Editor, American Electrician:

I have been troubled with blackening of the commutator similar to that which troubles Mr. Maloney, and it is barely possible that the cause is the same. I am operating one 500-volt machine and one 110-volt machine, both direct-connected to their engines. When either of them becomes overloaded, the commutator blackens, and always at the same place relative to the engine crank position; the segments under the brushes when the engine is at the point of cut-off are the ones that blacken. I doubt if a direct-current dynamo direct-connected to a single-crank engine can be prevented from showing this trouble, which seems to be due to the vibration occurring at the cut-off position of the piston and crank.

Springfield, Mass. C. F. Barden.

To the Editor, American Electrician:

Referring to Mr. Maloney's commutator trouble, described by him in the July number of your paper, I would suggest that it may be due to grounds in the armature and in the main current outside the machine which cause heavy currents to pass the brushes and burn the segments under them when the armature is in the position giving maximum difference of potential between the armature grounds and those outside. This may be verified or disproved by carefully clearing the external circuits of all leaks, or disconnecting the machine from the switchboard and running it on an artificial load connected directly to the terminals and absolutely free from grounds. Systematic and rigid testing will certainly reveal the cause, and that is perhaps the best course to pursue.

The trouble may also be due to unstable contact by the affected brushes, resulting from eccentric motion of the commutator. The effect on the commutator is greatest at the positive brushes because the current passes from the commutator to these brushes and the damage done by an arc is worse at the positive side of the interrupted circuit; at the negative brushes, the brush faces suffer more than the commutator.

Henry Mulford.

Patchogue, L. I., N. Y.

To the Editor, American Electrician:

The trouble described by Mr. Maloney in the July number of the American Electrician is probably due to a lump in his belt, such as a thick place where the belt is spliced. Or if the pulley is covered to prevent slipping, there may be a high spot in the covering which causes the armature to jump when it comes under the belt. If the dynamo is direct-connected to its engine the trouble may be caused by vibration due to lost motion in the cross-head or crank-pin boxes. The fact that the machine is on the positive side of the system would, of course, not affect it, so far as the foregoing causes are concerned.

Brooklyn, N. Y. Herbert B. Brand.

To the Editor, American Electrician:

I have had the same trouble that Mr. Maloney describes in your last issue, caused from a "flat" in the commutator surface, and I cannot think of anything else that could cause it. If his commutator contains any low bars or flats, or is out of true in any respect, I would suggest that it be turned down as soon as possible; in the meantime, the commutator should be kept clean by sandpapering. Sandpapering will not remedy the trouble, however, because the sandpaper cuts the low bars as well as the others.

Des Moines, Iowa. Joe Fager.

To the Editor, American Electrician:

Mr. Maloney's commutator trouble is probably due to flat spots on the commutator surface. Sandpapering will not help matters permanently; the only cure is to turn the commutator true.

Newark, N. J. James J. Fox.

To the Editor, American Electrician:

Mr. Maloney's commutator trouble is very easily remedied. The segments that blacken have become flattened, and cannot be made right by sandpapering. The commutator should be turned off perfectly true.

R. G. Kausch.

To the Editor, American Electrician:

Mr. Maloney's commutator trouble, described in the last number of your paper, may be due to any one of several causes or a combination of them. If there is any source of regularly recurring vibration, this may cause the brushes to bounce a minute distance away from the commutator surface. If the commutator was not thoroughly baked out when the machine was built, the insulation may have shrunk, leaving the segments insecurely held; the result of this is that some bars have been jarred below the circular outline of the commutator and the brushes bounce and chatter when they strike these bars. The commutator should be carefully examined for this trouble, and if it exists the heads should be drawn home tight, little by little, tapping the bars all around during the tightening process; when the bolts cannot be tightened further without endangering their threads, the commutator should be turned down.

Brooklyn, N. Y. Geo. W. Malcolm.

To the Editor, American Electrician:

Referring to Mr. Maloney's commutator trouble, I would suggest that sparking and blackening of the commutator are caused by unsymmetrical positions of the brushes, untrue commutator surface, excessive vibration and other causes. Evidently, Mr. Maloney's commutator needs truing up, because the blackening always occurs at the same place.

Ladonia, Texas. Wilson A. McCown.

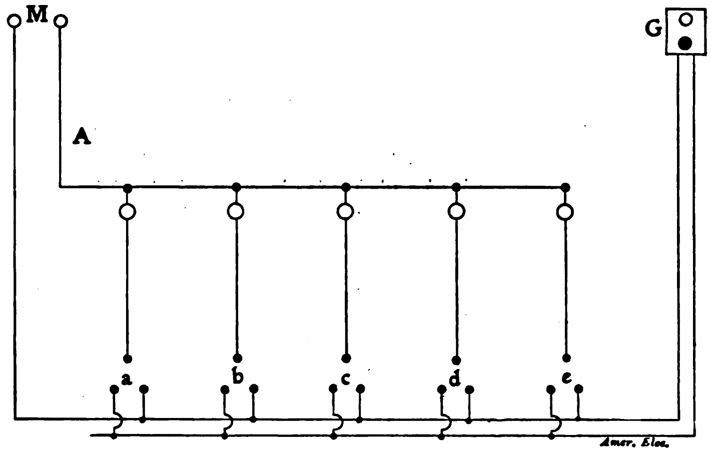

FIG. 1.—MR. MALCOLM'S SOLUTION.

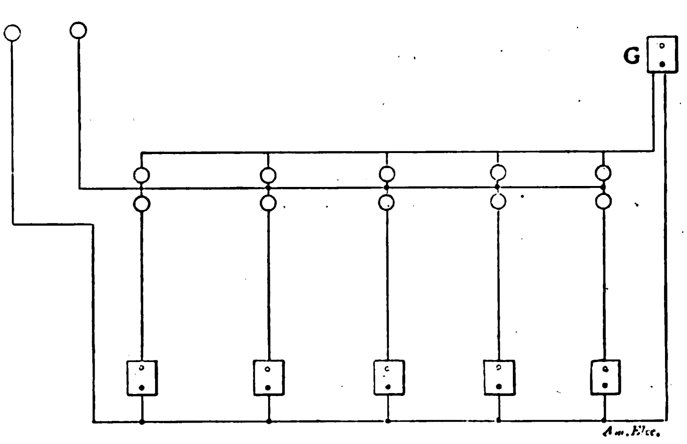

FIG. 2.—MR. SALTER'S SOLUTION.

To the Editor, American Electrician:

Referring to the commutator trouble experienced by Mr. V. P. Maloney, as described in the July number of the paper, I have often been able to correct such troubles in the commutators of street railway dynamos by merely resoldering the leads in the commutator lugs. The leads may be apparently secure in the ends of the bars, but resoldering may show that they were not, and may correct his trouble as it frequently has mine.

Cleveland, Ohio. Arthur B. Weeks.

Mr. Laughlin's Problem in Switch Connections.

To the Editor, American Electrician:

The accompanying diagram (Fig. 1) is submitted as a solution of Mr. Laughlin's problem, published last month. The individual switches are of the three-point or single-pole, two-way type and the gang switch is a single-pole affair connected so as to consolidate the two alternate points of all the individual switches. As long as the gang switch is open, the outlets may be controlled separately by the individual switches, but when the gang switch is closed, all of the outlets are connected to the supply circuit regardless of the positions of the individual switches. The latter, of course, are of the type that must always be on one or the other of the alternate contacts; that is, the mechanism must not be able to remain stationary in a mid-position, leaving the switch open-circuited.

This accomplishes what I infer to be Mr. Laughlin's purpose; namely, the *lighting* of all the lamps by the gang switch, irrespective of the individual switches. If it be desired also to extinguish all the lamps by means of the gang switch, irrespective of the others, then two switches must be used at *G*, one connected as shown and the other inserted in the line *A*, between the outlets and the supply circuit; with this second switch open, all of the lights will be extinguished; with it closed, the conditions would be exactly as in the case shown by the diagram.

Brooklyn, N. Y. Geo. W. Malcolm.

[Solutions exactly corresponding to Mr. Malcolm's diagram have been received from Jas. B. Dillon, Louisville, Ky.; Carl W. Littler, Swissvale, Pa.; E. C. McLean, New York; Wm. Merrill, Wilmington, Del.; Rene Moncel, Montreal, Canada, and G. S. Partlow, Essex Junction, Vt. None of them, however, included the alternative arrangement for extinguishing as well as lighting all of the lamps regardless of the individual switches.—Editor.]

To the Editor, American Electrician:

I enclose a diagram of connections (Fig. 2) as a solution of Mr. Laughlin's problem as stated in last month's number of your paper. My solution consists of providing two sets of lamps at the outlets, one set being controlled by the individual switches and the other by the gang switch *G*. I have used this arrangement for just such a purpose as he intimates. As he did not state that only one lamp is to be supplied from each outlet, I assume that there may be more than one, in which case this solution would be practical.

Maplewood, N. J. Ralph E. Salter.

Mr. Clark's Voltage Effect.

To the Editor, American Electrician:

The unusual voltage effect described by Mr. Clark in your last number is due to the fact that when the load is unbalanced to or beyond a certain extent the drop in the neutral wire is excessive and that wire therefore fails to equalize the voltage at the distribution centre. For example, if the load be such that the drop in the positive main is 6 volts, that in the neutral 4 volts and that in the negative main 2 volts, with the positive dynamo adjusted to give 110 volts at the lamps the voltage between the neutral and the negative main at the end of the feeder will be higher than that of the negative dynamo, no matter what the adjustment of the latter may be, within ordinary limits. Thus, in order to bring the lamp voltage down to 110 on the negative side, the dynamo on that side must be reduced to 108 volts, while if it be adjusted for 120 volts, like its mate, the voltage at the end of its side of the feeder will be 122.

The difference between the voltage at the lamps on the lightly-loaded side and the e.m.f. of the dynamo on that side, in any three-wire system, will always be equal to the difference between the drop in the neutral wire and the drop in the lightly-loaded main, and of the same character; that is, the lamp voltage is more or less than the dynamo voltage according as the neutral drop is more or less than the drop in the lighter main. When the drop in the neutral is the same as the drop in the lightly-loaded main, the voltage at the smaller load will be equal to that of the lightly-loaded dynamo.

Brooklyn, N. Y. Geo. W. Malcolm.

[Substantially the same explanation, without the statement of principle contained in the last paragraph, has been received from W. H. Freedman, Burlington, Vt., Henry Mulford, Patchogue, L. I., N. Y.; S. Von Prusinowski, Chicago, Ill., and O. Williamson, New York.—Editor.]

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

How does alternating current pass through a tin-foil condenser, and why will not direct current pass through it? J. H. G.

The condenser is fully explained in the Lessons Department of the April, 1904, number.

Where can I get the motor castings and transmission gear of the automobile desvribed in the July number? M. B. W.

So far as we know you cannot buy them ready-made; our "how-to-make" articles are not intended to advertise apparatus that can be bought on open market, but to enable those interested to build the apparatus.

Why is a recording watt-meter called an "integrating" meter? C. S.

Because it integrates the time-power load. That is, it measures the power during each small interval of time, multiplies it by that minute interval and adds up all of the products of time and power; this process is called "integration."

How can I rewind a 2000-volt 125-cycle transformer for 500 volts and 25 cycles? The secondary voltage to remain unchanged. C. W. G.

Use wire three gauge numbers larger than the present primary wire and put in as many turns as possible up to the same number that is now in the primary winding. Leave the secondary winding as it is.

I have a direct-current fan motor that I wish to use on an alternating-current circuit of the same voltage as the motor; how can it be changed to work on that circuit? M. C. A.

It cannot be changed so as to work satisfactorily on the alternating-current circuit. Exchange it for an alternating-current fan motor.

A constant-potential dynamo runs as a motor when connected to a suitable source, but will not generate when driven by an engine. It is a compound-wound machine of 6.6 kilowatts output. What is the trouble? F. G. K.

You ran it in the wrong direction as a dynamo or at too low a speed. The residual magnetism is evidently low and the machine requires at least full speed to "pick up." It should run in the same direction as a dynamo that it did as a motor.

What is the best packing for the cylinder head of a gasoline engine? (2) What causes explosions in the exhaust pipe of such an engine? (3) How can exhaust pipe explosions be prevented? A. C.

A ground joint. (2) The passage through the cylinder of a charge without being ignited. Failure to ignite may be due to too poor a mixture or defective igniting gear. (3) That depends on the exact cause of the failure to ignite; no general rule can be given.

How large a spark coil should be used for wireless telegraphy over a distance of three miles? (2) Can a telegraph circuit be operated over a metallic telephone circuit without interfering with the clearness of speech? (3) Why does a hand-power plating dynamo fail to generate? G. C. T.

Not less than a 3-inch spark. (2) Yes; it is done every day. (3) Because it is out of order. If you can furnish some definite information as to its condition, a more definite reply can be given. A list of possible causes a column long could be cited.

Please define "phase" and "cycle." (2) Is there any relation between them? D. F. D.

When two alternating currents reverse at the same rate but at different instants, they are "out of phase" with each other; if they reverse exactly together, they are "in phase." A cycle is one complete reversal of current or e.m.f. Thus, when a current starts from zero, rises to maximum in one direction, falls back to zero, rises to maximum in the opposite direction and again falls to zero, it has passed through one "cycle." (2) No.

How thick should the armature discs be in the 75-light dynamo described in the January, 1901, number of the American Electrician? (2) Should the discs be insulated from each other? (3) How can the 41 coils be put in 40 slots? (4) Do the slots run parallel to the shaft? (5) What is the formula for the horse-power required to drive a dynamo at a given load? E. W. P.

Not more than 25 mils. (2) Yes; varnish one side of each disc with a thin insulating compound. (3) The number 40 was a typographical error; the number of slots must be 41. (4) Yes. (5) Multiply the efficiency by 746 and divide the dynamo output in watts by the result. Thus, if the efficiency is 0.91 and the output in watts 75,000, the horsepower required at the shaft will be 75,000 ÷ 0.91 × 746 = 110.5 scant.

What is meant by an "open-circuit" arc lamp? (2) What are its advantages? (3) How does a differential arc lamp operate? W. T. K.

A lamp in which the carbons are held apart by the mechanism when the lamp is cut out of circuit. (2) For alternating-current work the advantage is that only a shunt magnet is used for regulating and striking the arc, and the power factor of the lamp is higher than it would otherwise be. There are no advantages of importance in direct-current work. (3) A series magnet or winding strikes the arc and tends to keep the carbons apart; a shunt magnet or winding opposes the series magnet or winding and tends to release the upper carbon; when the arc is too long, the shunt magnet overpowers the other and allows the carbon to feed.

In transferring a three-phase alternator from one set of bus-bars to another without shutting down, the machine fell slightly out of step and took a heavy cross current to pull in again. The two sets of bus-bars were connected by transformers during the transfer; in changing over, one leg of the alternator was transferred, while the other two remained connected to the first bus-bars, then the second leg, and finally the third. The machine was adjusted to take a slight motor current before transferring. Why did it get out of step? L. A. S.

Because during the interval while the second leg was being transferred the machine was not connected operatively to either circuit and there was nothing to keep it in step. One leg was connected to the primary of the transformers forming the link between the bus-bars and the other leg to the secondary; consequently the machine received no current from the other generating sets.

If the power factor of an induction motor is 78 and the efficiency 82% with an input of 48 kilowatts *apparent* power, what will be the actual power? (2) What are the essential points to be covered in a set of specifications for a direct-connected engine and generator, the engine to operate non-condensing at 125 lbs. initial pressure and the generator to be a constant-potential, direct-current machine, for incandescent lighting? D. P. R.

The intake is 48,000 × 0.78 = 37,440 watts true power and the power at the pulley is 37,440 × 0.82 ÷ 746 = 41.15 horsepower. (2) The essential points cannot be given without writing the specifications practically in full. The principal points to be covered are the power by the engine at rated speed and initial pressure; steam consumed per horse-power developed at different loads; speed variation between no-load and full load; mechanical efficiency of the engine; commercial efficiency of the generator at half, three-quarters and full load; temperature rise of different generator parts at full load; overload ability without sparking or dangerous heating for one hour; the same for one minute; voltage regulation between no load and full load, taking into consideration the speed fluctuation of the engine.

Why is a railway motor more liable to spark and flash at the commutator than a stationary machine of equally reputable make? (2) Is the static capacity of ordinary central station primary lines large enough to require consideration in laying out circuits? (3) What causes a direct-current multipolar generator to burn every third or fourth bar of the commutator while all the other bars remain in good condition except the near edges of the bars next to the burnt ones? W. T. K.

It is more likely to spark because it is a reversing machine and therefore the brushes must be set on the theoretical neutral line, while the armature reaction causes the actual neutral line to shift to one side or the other of the theoretical line, according to the direction of rotation. The tendency to flashing is due to the relatively small number of commutator segments and the jolting which the brushes receive from the car, causing them to bounce away from the commutator a slight distance. (2) Not unless the station is a long distance (say 10 miles or more) from the center of distribution or the lines are underground cables. (3) The armature slots contain either three or four coils, so that one of the group is not in the proper part of the magnetic field when it undergoes commutation; consequently, when the bar connected to that coil passes a brush, there is sparking, which burns the bar. The sparking may be ***under*** the edge of the brush and therefore invisible on casual inspection, but it is there.

RIDGWAY TWO-BELT CONVEYOR SYSTEM.

The accompanying engravings illustrate a departure from the usual belt-conveyor system, in that two belts are used in place of one. In the two-belt system an interior troughing and supporting belt runs over its individual head and tail pulleys, having separate take-ups, and is entirely independent of the conveying belt proper. The conveying belt is threaded over its head and tail pulleys in the usual manner, and has its separate take-up so that the two belts, although moving together are separate and distinct, and this enables the conveying belt to be lifted off the supporting belt and out of the troughing blocks and passed through either a stationary dumper or a movable tripper.

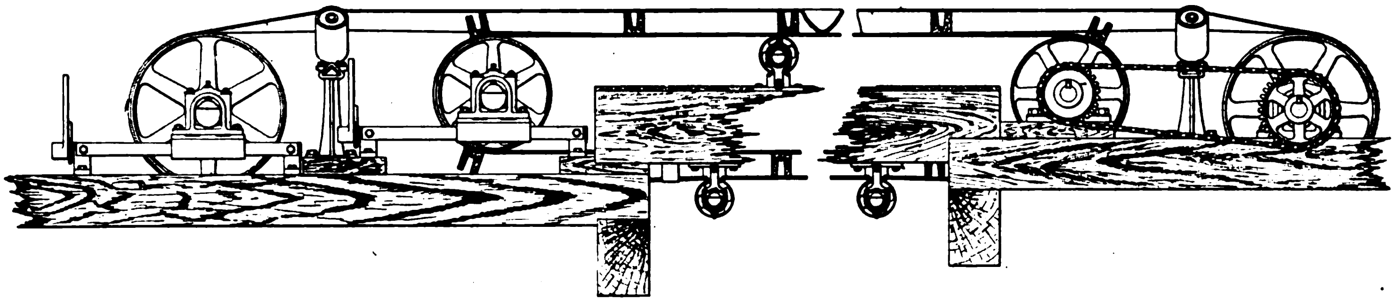

FIG. 1.—RIDGWAY TWO-BELT CONVEYOR.

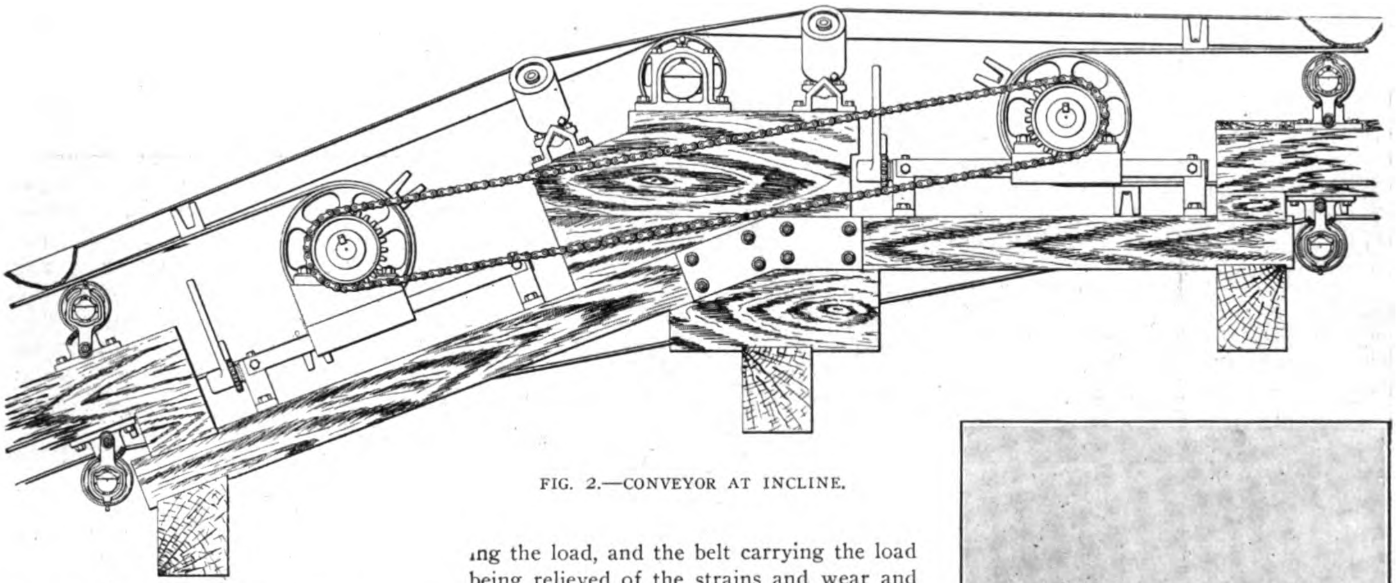

FIG. 2.—CONVEYOR AT INCLINE.

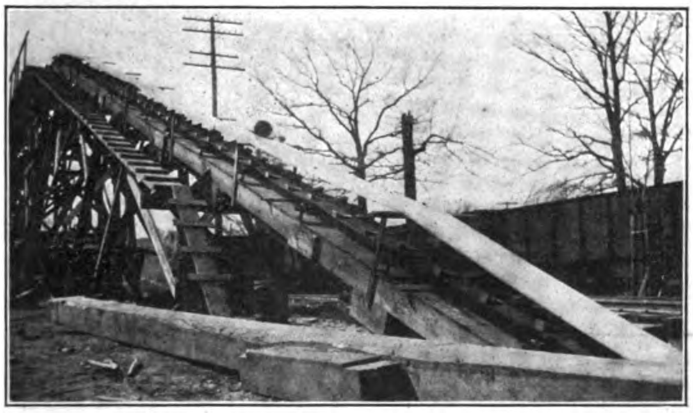

FIG. 3.—RIDGWAY CONVEYOR SHOWING TROUGHING BELT.

The conveying belt is said to have no work put upon it other than what is required to drive the lower carriers and its own head and tail pulleys; all the carriers on the upper line, which comprise two-thirds of the total number used, being revolved by the inner supporting belt. The strains, therefore, are divided, the belt revolving two-thirds of the moving parts not being subject to the wear and tear of carrying the load, and the belt carrying the load being relieved of the strains and wear and tear of revolving the majority of the moving parts of the machine.

The interior belt is driven by a compensating drive (roller or block chain sprocket drive) from the main driving shaft and with the two belts in tension just sufficient to prevent slip on their driving pulleys; both belts move at the same speed in the same direction, and there is claimed to be no rub of the conveying belt on the troughing blocks.

At the points where the conveying belt meets the interior supporting belt, a pair of concentrating rolls lifts the edge of the belt and drops it into the troughing blocks. This same method is used where the conveying belt leaves the troughing blocks at the opposite end.

The troughing blocks are made of whitewood, dipped in crude or linseed oil, to prevent checking, and are rivetted to the belt by 5-32" round, flat-headed, copper rivets. The carriers used are straight rollers fastened to steel shafts revolving in babbitted boxes, the boxes being ball and socket, ring-oiling, felt-washered and dust-proof. The carrier belt, or conveying belt proper, lies in a natural position, with the strains distributed, it is claimed, over its whole width.

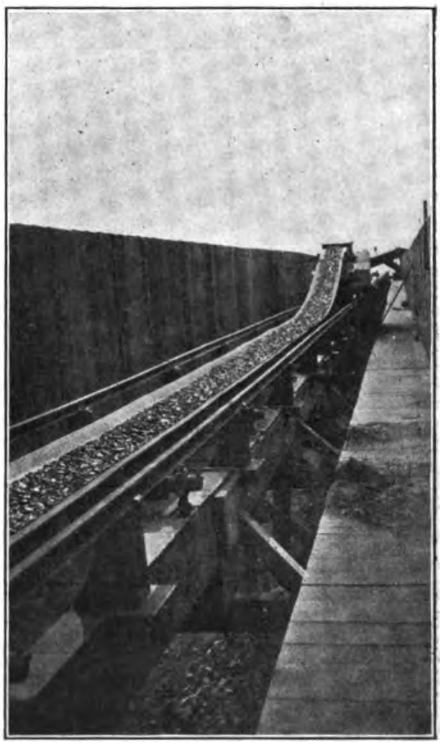

FIG. 4.—RIDGWAY CONVEYOR SYSTEM.

Fig. 3 shows the interior troughing and carrying belt with its troughing blocks attached. This interior belt by a compensating drive is driven at the same speed as the upper carrying belt and the two move together through their entire travel on both the upper and lower sides. The inner or troughing belt carries the outer or conveying belt through the upper line of working travel, and the outer belt carries the inner belt on its return, and through its travel in the lower line. The ability to use straight rollers enables the use of light castings. This has a double advantage in reducing weight and minimizing power. Only a clean belt comes in contact with the upper carriers, which comprise two-thirds of the total number used. The system is owned by the Ridgway Belt Conveyor Company, New York City.

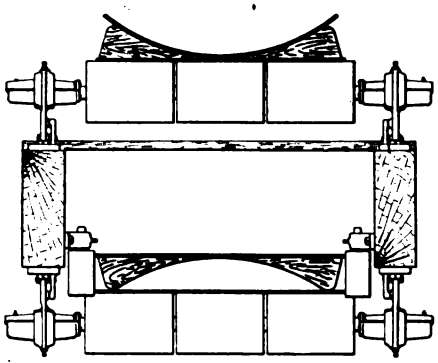

FIG. 5.—CROSS-SECTION OF CONVEYOR.

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UNDERGROUND CONDUIT SYSTEM AT MANCHESTER, MASS.

During the past month the conduit system of the Manchester Electric Company, at Manchester, Mass., has been completed. The work was begun last fall and the total trench feet opened was about 45,000. Manchester is a popular watering place on the Atlantic Ocean, having several fine beaches and bold promontories. It is 23 miles northeast of Boston on the Gloucester Division of the Boston & Maine Railroad, and is the summer residence district of many of the moneyed men of the Hub. The current for the most part is used for residential lighting.

A peculiarity of the system is that fully 30 per cent of the conduit is embedded in rock. The size of the duct run varies from two ducts at the outlying ends of the system to the main run of nine ducts entering the power-house. In carrying out the work an organization of about 450 men was required and a complete outfit of drills, together with a stone-crushing plant. Here all of the granite excavated from the trenches was crushed to a size suitable for concrete.

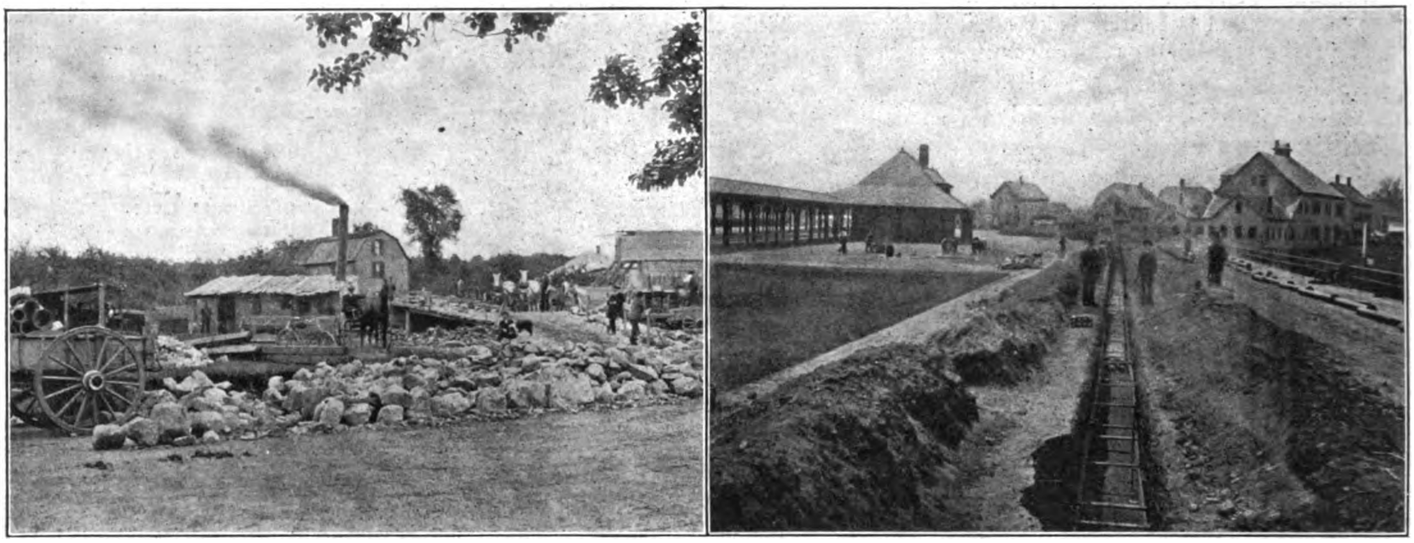

FIG. 1.—ROCK-CRUSHING EQUIPMENT AND CONDUIT TRENCH AT MANCHESTER.—FIG. 2.

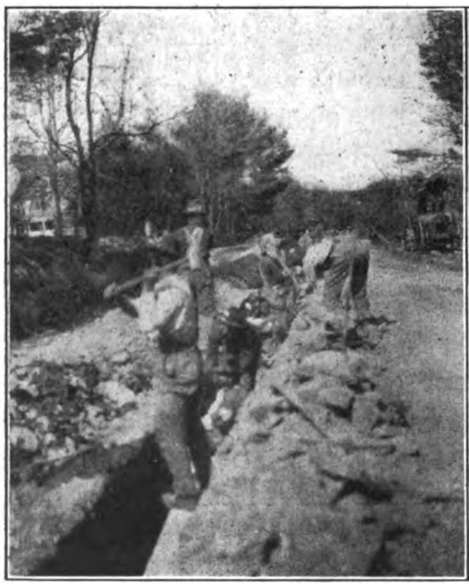

FIG. 3.—DRILLING A TRENCH IN THE ROCK.

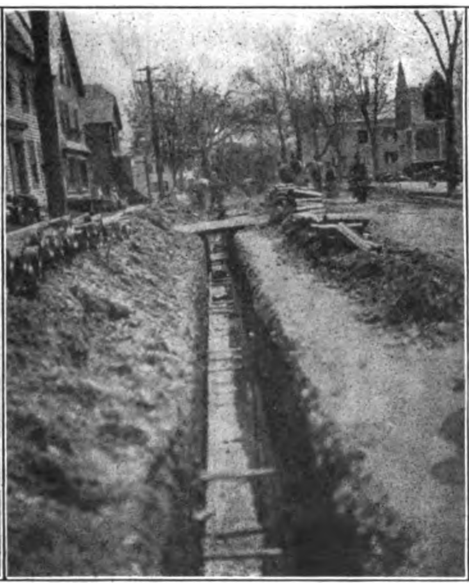

FIG. 4.—CONDUIT TRENCH.

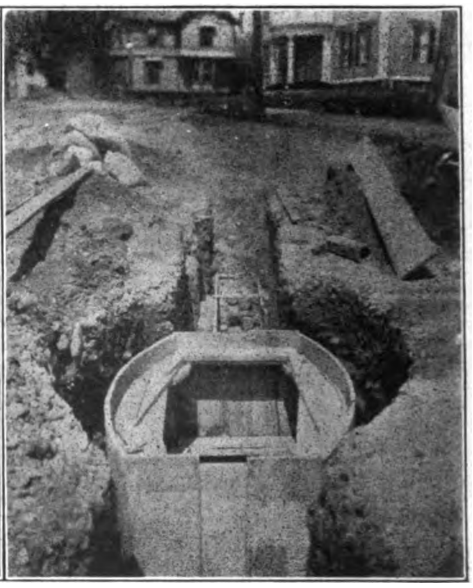

FIG. 5.—CONCRETE CONDUIT FORM.

After the trenches were excavated to grade, a line of boards or boxes was placed in the trench for the purpose of giving a straight line of trench and also to economize in the use of concrete, since the trenches were excavated by blasting with dynamite the resulting width being much greater than was required for the installation of the conduits. After the boxes were placed in the trenches a layer of concrete 3 inches thick was placed on the bottom. Upon this the tile ducts were laid and the space between the sides of the boxes and the tiles, 3 inches, was filled with concrete, and then 3 inches of concrete was placed on the top, thus encasing the tile completely in concrete.

The manholes, of which there are over 200, were built for the most part of concrete. A few brick manholes were built where a great quantity of water was encountered, and in some cases manholes of collapsible steel were installed. These are made in two pieces and keyed on the curved side of the form.They are then given the desired shape by means of turnbuckles. The concrete manholes were built as shown by Fig. 5.

After the sides had been filled with concrete and allowed to set for 48 hours, the forms were removed and the manholes roofed over by placing I-beams across the top and filling in the space between the beams with concrete. The manhole casting was then set on top of this roof.

Where the ducts enter the manhole they are recessed 4 inches from the inner face of the manhole wall. Thimbles are built in each manhole, so that when connections are desired for house service it is not necessary to cut into the manhole walls. All the ducts are laid in straight lines, any turns necessary being made in the manholes; so that oftentimes these are 30 feet apart, while in other cases they are 300 feet apart. Macadam roads are used throughout the town.

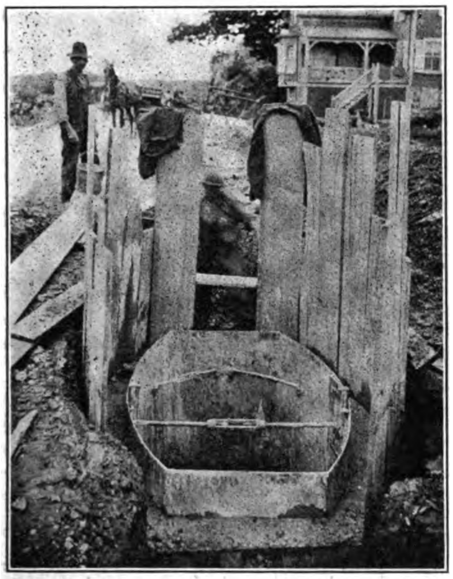

FIG. 6.—COLLAPSIBLE STEEL MANHOLE.

The work was carried on under the supervision of the chief engineer of the Manchester Electric Company, G. W. Palmer, Jr., and L. R. Cobb, resident engineer. Mr. G. M. Gest, of New York, was the contractor for the entire conduit system.

STURTEVANT STANDARD AND PONY ECONOMIZERS.

The amount of heat rejected with the smoke and waste gases in the generation of steam above that which is necessary for the production of a suitable natural draft is in most cases excessive; so that the utilization of economizers in connection with steam production is worthy of consideration. We illustrate herewith two types of economizers made by the B. F. Sturtevant Co., of Boston, Mass., which are almost similar in design and differ only in size. The "Standard" economizer shown by Fig. 1 is intended for use in conjunction with boilers of almost any capacity, but is more practical for boilers having capacities of 350 horsepower and over. The "Pony" economizer shown by Fig. 2 is built on a smaller scale and is more commonly used in connection with plants of from 50 to 500 horsepower capacity. It differs from the "Standard" only in some minor constructional details. The economizers are first and foremost flue feed-water heaters, but their value in the steam plant is not alone measured by the increase in the temperature of the boiler feed water.

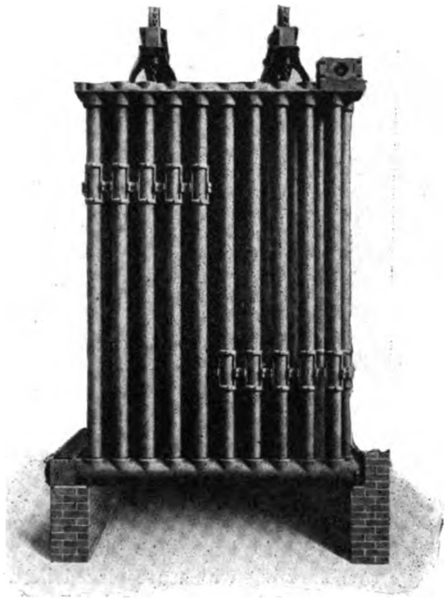

FIG. 1.—STANDARD ECONOMIZER.

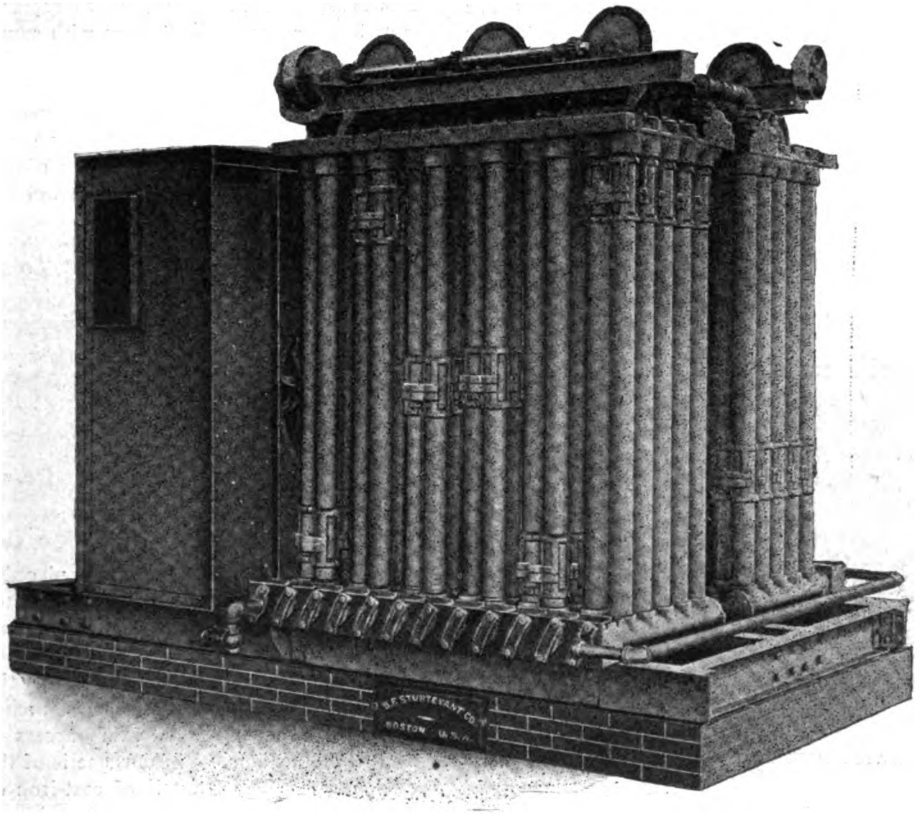

FIG. 2.—STURTEVANT PONY ECONOMIZER.

To agitate the gases and allow them to come into contact with the maximum area of the economizer pipes, thus utilizing a maximum amount of the waste heat from the boiler, a patent system of staggered pipes is employed. As will be seen from the illustrations the several sections are arranged to that the pipes of any one section are longitudinally opposite the spaces between the pipes of the adjoining sections. The economizer is also built with straight pipes.

As few joints as possible are employed and in order to make the deteriorating effect of joints as small as possible, each section is fitted into its wall box or branch pipe with tapered iron-to-iron joints, no packing being used. All caps are also fitted with taper iron-to-iron joints. Branch pipes are eliminated at the top of the economizer, and all the pipes used are of gray iron and cast on end. Both ends are tapered and the pipes forced into the headers by hydraulic pressure. The caps have taper ground iron-to-iron joints and can be easily removed. Those directly over the pipes in the top headers are tapered, while all of the others are held in place by through bolts. The bolts do not come into contact with the water and therefore are not subject to its deteriorating effects.

The headers are of cast iron, the bearing parts being machined and finished to gauge in order that the taper joints may be tight. As a substitute for the manifold header with its branch pipes, a wall box is employed. This is placed in the front side wall of the economizer. The economizers are fitted with relief valves, blow-off valves and cast-iron soot-pit doors. The foundations are

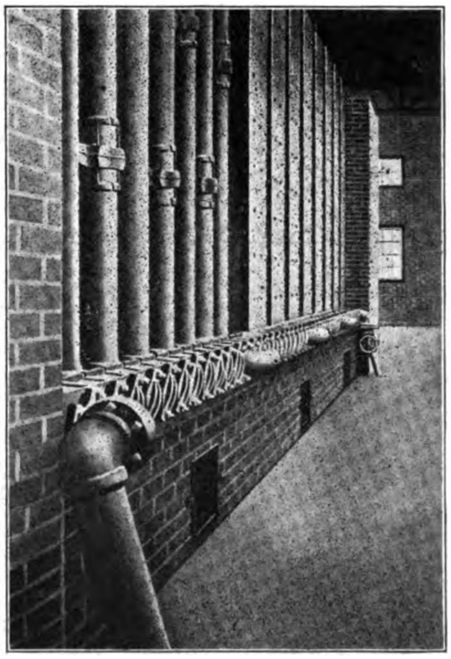

FIG. 3.—STANDARD ECONOMIZER CONNECTED.

usually of brick and sometimes of structural steel. With brick foundations a chamber is formed under the economizer in which soot accumulates. The inlet and outlet flues are of brick or sheet iron, and when of iron are built of double sheets about an inch apart filled with a non-conducting material.

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RUST WATER-TUBE BOILER.

Fig. 1 herewith shows a sectional elevation of the Rust water-tube boiler, manufactured by the Rust Boiler Company, of Pittsburg, Pa., and only recently placed on the market. The most novel feature in connection with the boiler is the special tube sheet used in the construction of the drums. This tube is formed by heating the fire plate to the proper temperature, then pressing in a hydraulic press fitted with dies especially constructed for that purpose, the pressing being done at one operation. An important feature of the construction of these tube sheets is that between each pressed-up portion and those adjacent there remain undisturbed cylindrical portions or belts of the original surface of the drum.

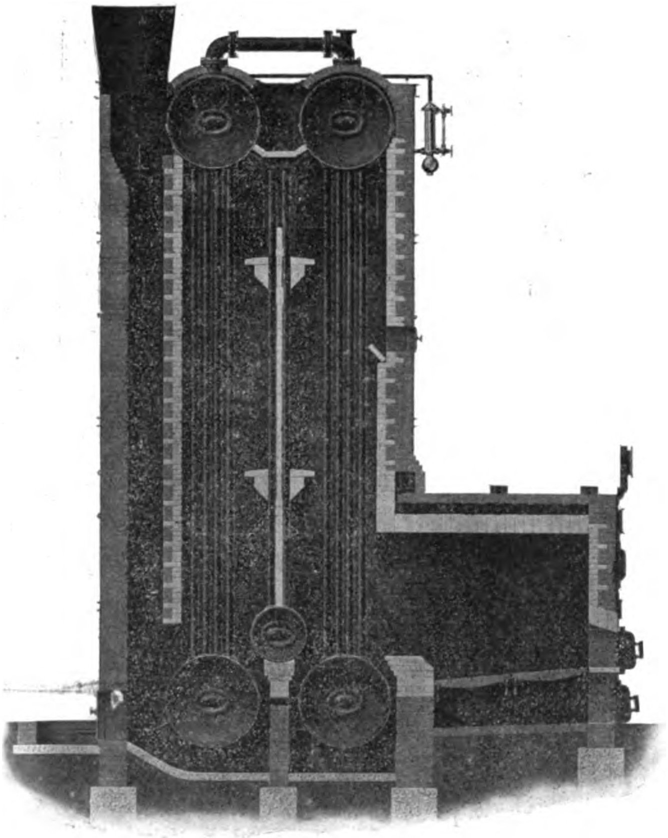


FIG. 1.—SECTIONAL ELEVATION OF THE RUST WATER-TUBE BOILER.

The boiler proper consists of two steam and water drums, two mud drums and an auxiliary drum, each steam and water drum being placed directly above a mud drum and connected by a bank of straight, vertical tubes, the two mud drums being connected by a row of tubes. The auxiliary drum is placed above and between the mud drums and is connected to one of them by a row of short tubes and to a series of small headers by a bank of straight vertical tubes. These headers are placed between the steam and water drums and connected by short, straight tubes or nipples. The holes for the tubes forming the main banks are so spaced that the tubes are staggered. Enough room is left between the tubes of the outside rows to remove the tubes of the inner rows. By the introduction of the auxiliary drum and central bank of tubes, the space necessarily left between the main banks of tubes is so utilized as to secure a serviceable and convenient support for the baffle wall, the tiles forming which are placed between and supported by the rows of tubes forming this bank, and owing to the consequent increased heating surface a boiler of larger capacity results without additional floor space, fittings or cost of setting. The boilers are made right and left hand, and are arranged to be set singly or in batteries of two. Each drum is provided with a manhole in one end to permit of access to the interior of the drum, and in the top of each header there is an oblong handhole through which to reach the interior of the tubes of the central bank. The steam spaces of the steam drums are connected by cross-pipes of liberal dimensions. On top of each is an outlet, on which is placed a safety valve. The steam outlet is placed on top of and at the center of the rear steam and water drum. The boiler is supported by four large cast-iron saddles resting on masonry foundations, one saddle being placed under each end of each mud drum, the saddles under one of the drums being placed on rollers so as to permit of any slight movement that may be necessary on account of expansion. By referring to the sectional view of the boiler it will be observed that the top of the central baffle wall is far enough below the headers to leave sufficient space for the products of combustion to pass from the front to the rear bank of tubes. It will also be observed that there are horizontal baffles or bracket tiles which project from this central baffled wall, and which serve to deflect the current of hot gases so as to force them toward and between the tubes of the main banks. At the top of the setting and bolted to the corner binders is placed a box-shaped frame made up of channels and plates, which furnishes a rigid support for the breeching and stack, and also serves to firmly bind the brickwork at the top of the setting, and at the same time results in a neat finish. On one side of the setting, near the top, are placed four small doors, which furnish access to the interior of the brickwork, and through which the tubes are passed in and out when replacements become necessary. Doors with small, self-closing openings, through which to insert a hose for blowing off the top of the tube sheets, are placed near the bottom of the setting, and other doors are furnished for securing access to the interior of the setting and for blowing deposits from the exterior of tubes. Over each steam and water drum and a little above it is placed a light steel arch, which serves as a center to support the brick arches over the drums to permit all possible upward expansion of the boiler, without interfering with the brick covering. Between the two arches are placed doors through which access is given to the headers. The furnace is of the exterior type. The front is of cast-iron of ornamental design, surmounted with a bracket in the center for supporting the steam gauge, and is so arranged as to permit the application of gas burners or any form of stoker.

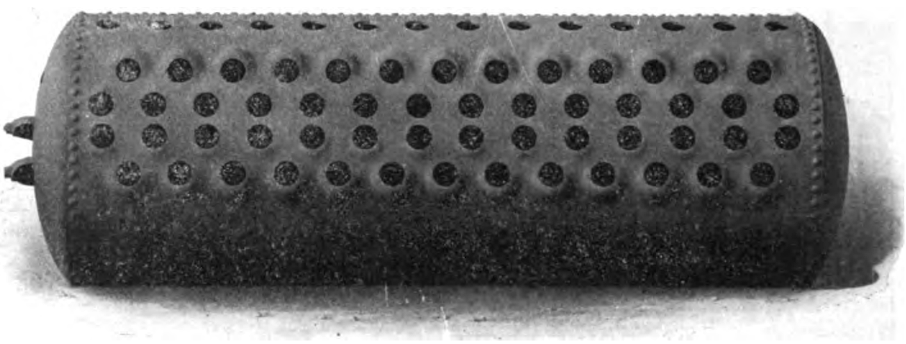


FIG. 2.—DRUM OF RUST WATER-TUBE BOILER.

FIG. 3.—RUST HEADER.

New Apparatus and Appliances

UNIVERSAL SHADE AND SOCKET.

Figs. 1 and 2 show two types of universal shade and socket brought out by the D'Olier Engineering Company, of Philadelphia, Pa. These electrical devices are among the latest on the market and were designed for use over desks, in draughting rooms and machine shops, and in fact any place where concentrated light is necessary. A particular feature of the shade and one to which the manufacturer calls attention, is that it is balanced when suspended from a flexible cord. Another feature is that both the shade and the socket can be turned completely around so that light can be had in any desired direction. The shades are made in three different finishes—polished brass, brush brass or brass body with green shade. As will be observed from the illustrations the devices are pleasing in appearance. They are, moreover, well made and the part next the lamp is painted with aluminum so as to add to its reflecting qualities.

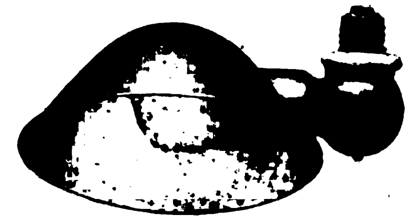


FIG. 1.—UNIVERSAL SHADE AND SOCKET.

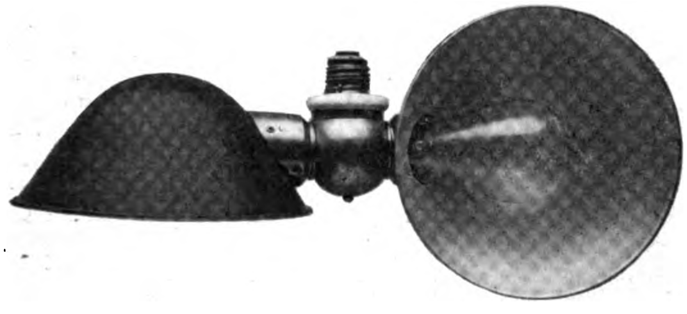


FIG. 2.—UNIVERSAL SHADE AND SOCKET.

RICHMOND "TYPE R. E." MOTORS AND GENERATORS.

Fig. 3 herewith shows one of a line of new direct-current motors brought out by the Richmond Electric Company of Richmond, Va., and designated "Type R. E." The usual circular frame is employed, the feet being cast with the frame and sticking well out with a wide spread. The armatures are made of thin steel accurately punched, annealed, rolled and japanned. They are then keyed upon the shaft and pressed together between malleable iron heads under hydraulic pressure. The heads form in one piece the thrust collars and oil slingers, and being shrunk on prevent the creeping of oil along the shafts from the bearings and getting into the windings and commutator. The head at the commutator end forms, as shown, a large taper on which the commutator shell fits. The commutator is held in place on this taper by a lock nut. Liberal bearings are provided, the linings being of aluminum bronze. The armature windings are composed of form-wound coils, being pressed to shape in steam molds. The commutator leads are swedged into the commutator bars, no solder, acids, etc., being used. The coils are held firmly in place by steel band wires which come below the surface of the core. The field coils are carefully wound on forms. They are not wound on bobbins, but are like the field coils of railway motors. The pole pieces are built of sheet steel punchings riveted together between end plates. The pole pieces are accurately fitted to the finished pole seats on the frame and are held in position by steel cap screws. They are readily removable and the projecting tips hold the coils firmly in place. The motor heads are cast in one piece and seat in counterbores in the frame and are held in place by four cap screws. The commutators are built on malleable iron shells which fit on the taper of the armature heads. The bars are deep and thoroughly insulated and are held to the shell by a malleable iron ring and lock nut, the latter being screwed down hard, while the commutator is under hydraulic pressure. The brush-holders are of brass and are simple in construction and design. Radial adjustment of the holder is provided so as to permit reduction of the commutator diameter without changing the angular distance between brushes. The carbon brushes slide in finished ways. The holders are securely bolted to the yoke, which is of paraffine soaked maple. The yoke is bolted to the brush-holder ring as shown. This ring clamps on the finished shoulder provided for it on the motor head. A projection on the ring goes into a recess in the head, this recess being of such a size as to permit a small movement of the ring in either direction from the neutral point. Terminal posts are avoided, the double rubber-covered leads being brought direct from the coils and brush-holders through rubber bushing inserted in holes drilled in the frame casting, thus adopting street railway methods. With commutator clean and brushes properly set, the motors are claimed not to spark under 200 to 300 per cent load. The motors are also built fully enclosed or semi-enclosed. The "R. E." type generators are built in sizes up to 20 kilowatts and for standard voltages from 100 to 500.

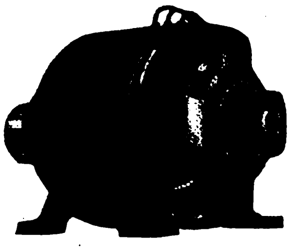


FIG. 3.—RICHMOND R. E. TYPE MOTOR.

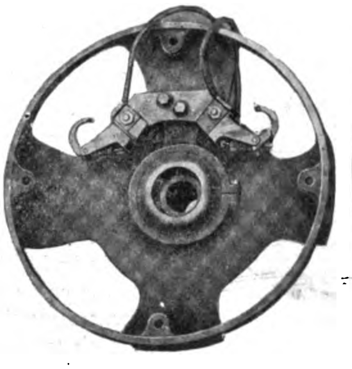


FIG. 5.—MOTOR HEAD.

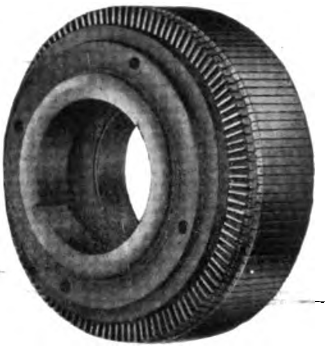


FIG. 6.—COMMUTATOR.

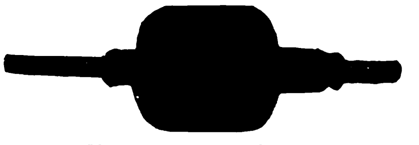


FIG. 4.—ARMATURE CORE.

HANGER FOR CABLES AND PIPES.

Fig. 7 herewith shows the Atlas hanger, which has been designed with a view to providing a simple hanger for electric conduit pipe, flexible conduit, wire cables and pipes of every description. The hanger itself is of ornamental design and by its use pipe can be hung one inch from the ceiling or support. The hanger requires no assembling or adjustment and when necessary it may be separated for changes to the pipe line. The style A hanger shown by Fig. 7 is furnished with either adjustable beam clamp, toggle bolt or expansion screw and is made for pipes from ¾ to 1 inch. As shown in Fig. 8 it consists of a hollow spherical casing in two halves, mounted to turn on a pivot. By means of two small screws, the casing grips the pivot firmly, the whole being thus combined as one piece. The casing is supplied with outlets diametrically opposite each other for the passage of pipes, cables, etc., or for supporting the ends of pipes carrying feed wires as in a junction box. The clamp is of malleable iron and is made in two parts provided with longitudinal slots, so as to be adjustable to any size of I-beam. Fig. 10 shows the hang-

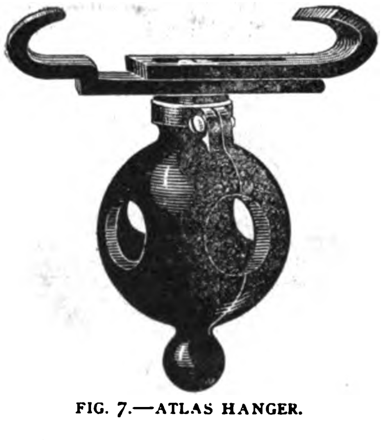


FIG. 7.—ATLAS HANGER.

er provided with a wooden screw. Style D hanger is shown in Fig. 9 and is especially adapted for large sizes of pipes. It has a pivot arrangement similar to the one shown in Fig 7 but a malleable iran ring is substituted for the hollow sphere, thus adapting it for steam, water and other large sizes of pipe. In order to make the hangers adaptable to various purposes they are supplied with pivots for use with ordinary beam clamps, lag screws, toggle bolts, etc. Where a perfectly insulated support is desired, the pivot is covered with a heavy layer of hard rubber. Style J hanger corresponds to style A, but is especially adapted for use as a junction box. The interior is coated with a heavy enamel and then baked, resulting in a smooth, polished surface which prevents the abrasion of the wires and possesses good insulating qualities. The hanger is made by the Atlas Hanger Manufacturing Company, of New York.

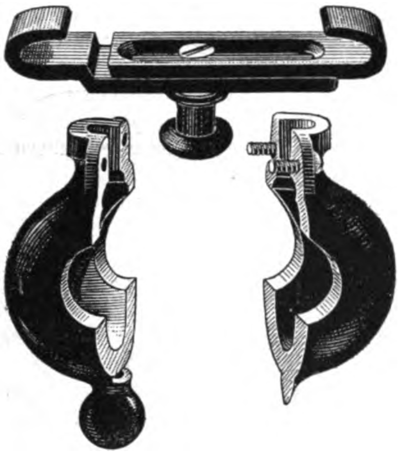
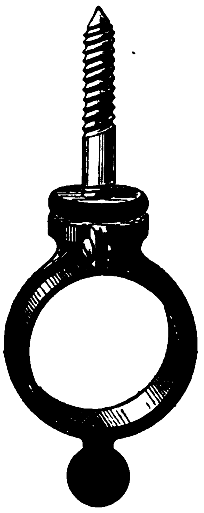


FIG. 8.—ATLAS HANGER DISASSEMBLED.



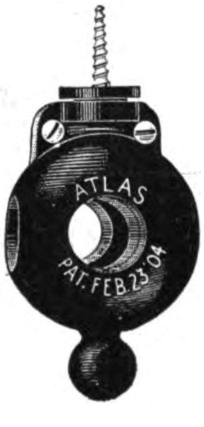


FIG. 9.—ATLAS HANGER.—FIG. 10.

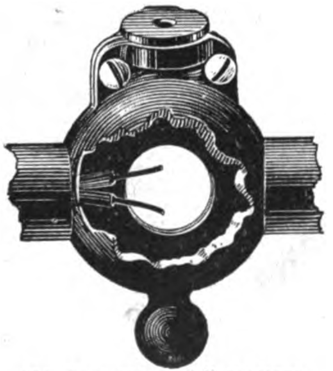


FIG. 11.—STYLE "J" HANGER.

LONG SCALE PORTABLE INSTRUMENTS.

Electrical engineers who employ the portable standard instruments in general use for the making of exact measurements of electrical quantities know how difficult it is to take accurate observations in those portions of the scale where the divisions are narrow, and the consequent uncertainty regarding results and difficulty in checking up a series of measurements taken with different instruments. The fact that only a portion of the scale is accurately legible and that it is not always possible to have at hand instruments of the proper range to cover all capacities properly, make it at times impossible to avoid the use of comparatively illegible divisions, and as a result the curve sheets of tests and tables of measurement show irregularities. To obviate such troubles the Department of Standards of the Westinghouse Electric and Manufacturing Company has designed the portable instruments illustrated herewith. The assortment comprises voltmeters, ammeters and single-phase and polyphase wattmeters. Their principal characteristics are convenience in use, permanence of calibration, accuracy and mechanical excellence.

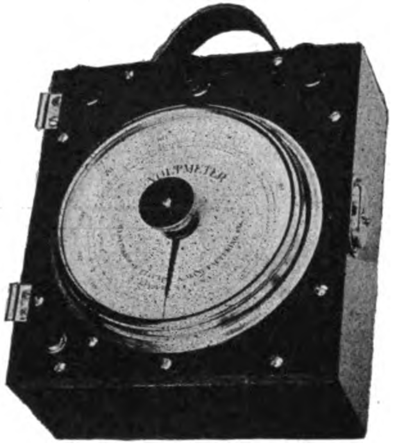


FIG. 12.—PORTABLE VOLTMETER.

As shown by the illustration, the voltmeter is zero-reading, this form having been found most suitable for measurements for which a voltmeter is used. In this form the readings are determined by the deflection of the milled head required to bring the index pointer to zero. Each instrument is made in two capacities, which in connection with the long scale enables the readings to be taken over a wide range of voltage with accuracy. It is astatic and therefore unaffected by external fields, and may be used on either alternating or direct currents. It is regularly made in capacities up to 600 volts, but may be furnished for any higher range desired by the use of a multiplier. The action is dead-beat. The ammeter is similar in external appearance to the voltmeter, with the exception of the terminals, which are designed for the use of heavier connecting wires, and the absence of the knurled head with its indicating pointer, this instrument reading direct. It is furnished with coils wound in two sections, which, by means of small connectors on the top, may be connected in series or in parallel, thus increasing the range of the instruments. The scale is long and open, being similar to the voltmeter in this respect. This instrument can be used on alternating currents only, but it is accurate over a long range of frequencies and may be used on circuits varying from 3000 to 8000 alternations without appreciable error. It is also said to be unaffected by changes of wave form on the circuit. The moving element is light, and being dead-beat will follow any variation of current. In the wattmeters, the scheme of subdividing the coils as adopted for the ammeters is carried out for both the series and potential windings, thus giving in one instrument four ranges in capacity. In addition to this, as the scales are uniformly spaced

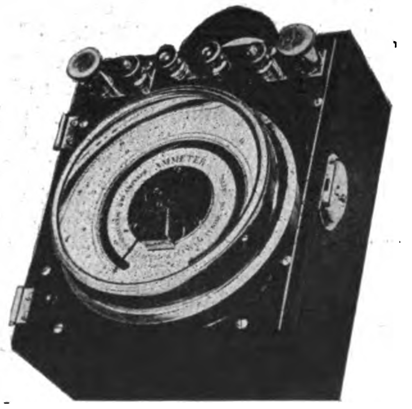


FIG. 13.—PORTABLE AMMETER.

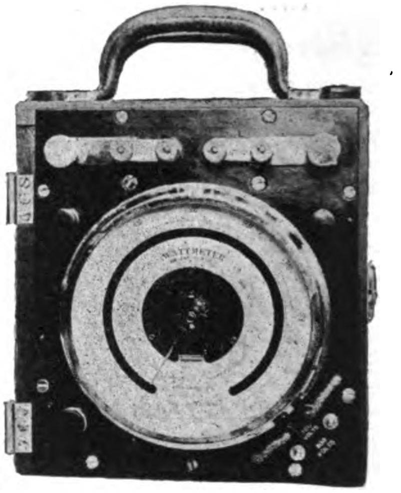


FIG. 14.—PORTABLE POLYPHASE WATTMETER.

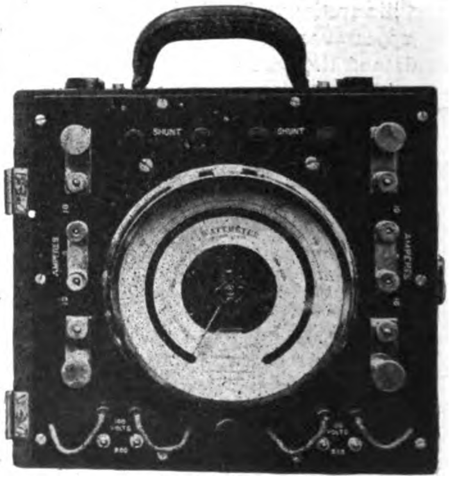


FIG. 15.—PORTABLE SINGLE-PHASE WATTMETER.

from zero to maximum, readings may be taken at any point with equal accuracy, so that one instrument will give a very large range. The wattmeters are suitable for use with alternating currents only, but like the ammeters, they may be used over a considerable range of frequency. The polyphase instrument consists of two singlephase mechanisms connected to one shaft, and indicating on a single dial the sum of the forces of the two mechanisms. It may be used for either two-phase or three-phase circuits and will, it is said, indicate correctly the total energy of a polyphase circuit irrespective of power factor or any unbalancing of the different phases.

BRISTOL'S THERMOMETER-THERMOSTAT.

The Bristol Co., of Waterbury, Conn., is placing a new instrument upon the market which combines a thermometer and thermostat. The instrument will give correct indications of the temperature of the atmosphere, gases or liquids at all times, and also serve as a thermostat to make electric connection at any predetermined limits of temperature for the purpose of operating controlling apparatus, alarms and the like. The construction and capabilities of this instrument will be best understood by referring to the interior view, Fig. 16, in which *A* is an arm pivoted at lower portion of the case, terminating in a point resting on the arc of the graduated scale and is held by friction at whatever point it may happen to be set. Two adjustable contact pieces, *B* and *C*, are carried by this arm. These contact pieces are capable of adjustment by means of a screw *D*, which is threaded so as to cause the contact pieces *B* and *C* to approach or recede at equal rates and distance from the center line of the arm *A*, upon which they are supported. They are also connected to binding posts as shown, which are used for making outside connections. These binding posts are located within the case. Three holes with insulating eyelets are provided in the lower portion of case, as shown, for the insertion of connecting wires. The arm *E*, moving over the graduated scale, indicates the changes of temperature where the instrument is located.

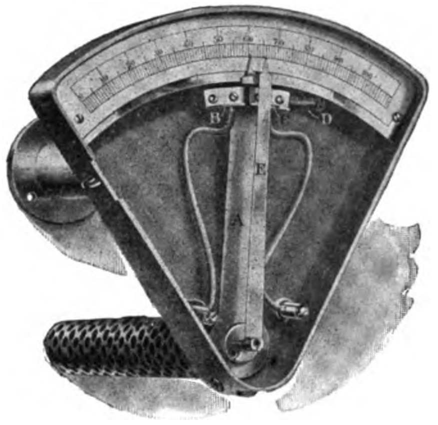


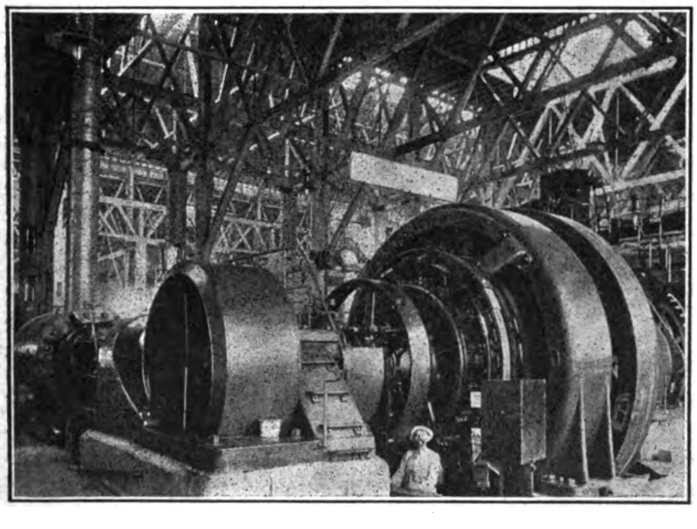
FIG. 16.—BRISTOL THERMOMETER RHEOSTAT.

This arm is operated by a recording thermometer tube placed in the perforated protecting projection extending from the back of the case as shown in the illustration. On the back of the indicating pointer *E* there is a raised portion which makes electric connection with the contact pieces. A novel feature of the instrument is that the temperature indicating arm *E* is not restrained by the thermometer-thermostatic contacts. Thus it will be seen that the controlling effect of the thermostat is adjustable as to position on the scale of the thermometer, and also as to high and low limits of operation, without in any way interfering with the indications of the thermometer in case the temperature does not remain, or is not controlled, within the limits for which contact pieces may be set. The instrument may be readily applied to liquids, as for instance to indicate the temperature and set into operation controlling apparatus for the brine in a refrigerating system or tank. For temperatures above the atmosphere, as those occurring in ovens, kilns, closed spaces, and liquids in pipes under pressure, a small bulb is located within the closed space or pipe. This bulb is connected with the thermometer-thermostat by a capillary tube filled with alcohol. The electric wires connecting with the adjustable thermostatic contacts may be carried to any point where the controlling apparatus may be located or where it is desired that an alarm shall be given.

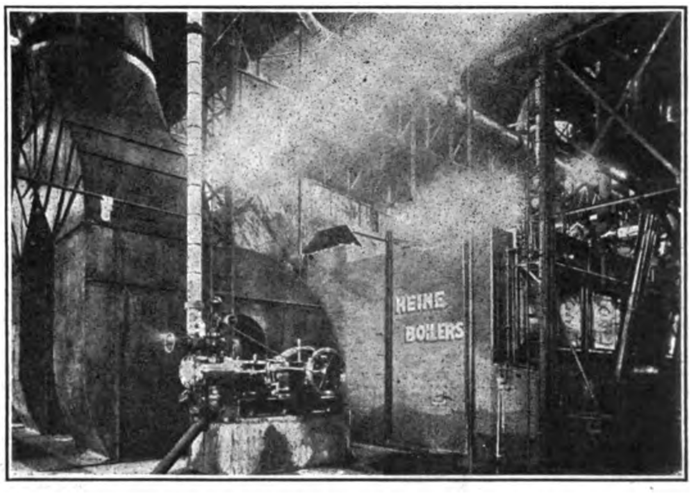
SOME EXHIBITS AT THE ST. LOUIS EXPOSITION.

We published last month a description of some of the exhibits at the Louisiana Purchase Exposition at St. Louis, and we describe this month as many additional exhibits as space limitations will allow. This by no means exhausts the number of available exhibits for description. Some of the larger exhibits, notably those of the Westinghouse and General Electric Company, will be described in a later issue.

CROCKER-WHEELER CO., Ampere, N. J., has as its exhibit all of the 500-volt, direct-current generators in the Machinery Building which supply the Intramural railway. The largest generator, which is of 900-kw. capacity, is direct connected to a Buckeye engine; two generators of 500 kilowatts are direct connected to Brown-Corliss engines; one generator of 600-kw. capacity is direct connected to a Lane & Bodley Corliss engine; a 400-kw. generator is operated by a Fleming four-valve engine, and a 500-kw. generator is operated by a Murray Iron Works Corliss engine. All these generators supply current through a railway switchboard built by the Walker Electric Company, of Philadelphia. The generators have given very satisfactory service since the opening of the Intramural railway.



CROCKER-WHEELER GENERATOR.



HEINE SAFETY BOILER COMPANY'S EXHIBIT.

HEINE SAFETY BOILER COMPANY, St. Louis, has a bank of boilers in the boiler house and an exhibit showing the construction of the Heine boilers and their different parts in the northwest corner of Machinery Building. In the boiler plant there are eight single-shell boilers rated at 400 horse-power each. These boilers are designed for a working pressure of 175 pounds to the square inch. Each boiler has 178 8-in. tubes and a drum 48 ins. in diameter. They are equipped with Green traveling chain grates, supplied with fuel from overhead bunkers, and in common with all the boilers in this plant are connected to induced draft apparatus. The company's exhibit space in Machinery Hall has a part of a full size Heine boiler showing the construction of the boiler heads, and also a complete model of a Heine boiler. The quality of steel tubing used in Heine boilers is illustrated by some tubing which has undergone very severe treatment in the way of bending and flattening without breaking.

THE EDISON COMPANIES' booth is divided into three sections, the central one being the headquarters of the American Institute of Electrical Engineers, the one to the right the office of the Association of Edison Illuminating Companies, and the one to the left the office of the Edison historical exhibit. The Edison Storage Battery Company's exhibit occupies an adjoining space. Three of the latest types of the Edison battery are shown, one cell of each type having part of the side cut out so as to show the internal construction. A 40-cell automobile battery is connected to a charging board to show the conditions under variable rate of charge and discharge and to demonstrate the high rates which can be used without effecting the battery. The different parts used in the construction of the cells are contained in a showcase. Plates are exhibited from a cell of an automobile which has run 4000 miles over rough roads. An historical collection of Edison storage cells is shown in a case, beginning with the first cell made and showing one of each type. There are also bottles containing nickel and iron oxides and graphite used in filling the pockets of the plates. A bottle containing electrolyte with all the sediment from a cell which supplied current to propel an automobile 5000 miles is also on exhibition. Enlarged curves showing the battery voltage at various discharge rates are displayed on the wall. Then different types of the Edison-Lalande primary battery and some fan motors operated by them are exhibited, as are also several of the Edison projecting kinetoscopes.

THE BRISTOL CO., Waterbury, Conn., makers of the Bristol instruments, make the handsome display shown in the engraving. The instruments of this company are successfully applied to the continuous recording of current voltage, wattage, steam pressure, water pressure, height of the water level, and temperatures up to stack temperatures of 800° F. An improvement which users of Bristol instruments will appreciate is exhibited; this is termed a stationary dial instrument, in which instead of removing the circular steel plate when charts are to be changed, the chart only in removed. This is slipped under guides in the vicinity of the recording pointer so that there is no necessity of removing the pointer or danger of bending it and throwing the instrument out of adjustment when renewing a chart. An ingenious instrument for recording slight variations in pressure is shown. This can be calibrated for use in indicating the level of water in a tank or the height of the tide. It consists of a recording pressure gauge connected to a long, thin, covered tube about the size of No. 12 wire outside diameter. Upon the end of this tube is a solid metal cylinder which, with the recording pressure gauge, is filled with the liquid. The tube is anchored to the bottom of the tank in which the rise and fall of level is to be measured. The variation in the depth of water cause variations in pressure which are recorded on the chart of the recording pressure gauge. An electrical alarm attachment can be used in connection with the recording instruments made by this company, so as to sound an alarm when the instrument records either high or low or both. One of the new instruments shown is an alternating-current recording wattmeter. All of the different types of instruments are ranged so that their operation can be demonstrated, and a 5000-ampere recording ammeter for use on station bus-bars is also exhibited.

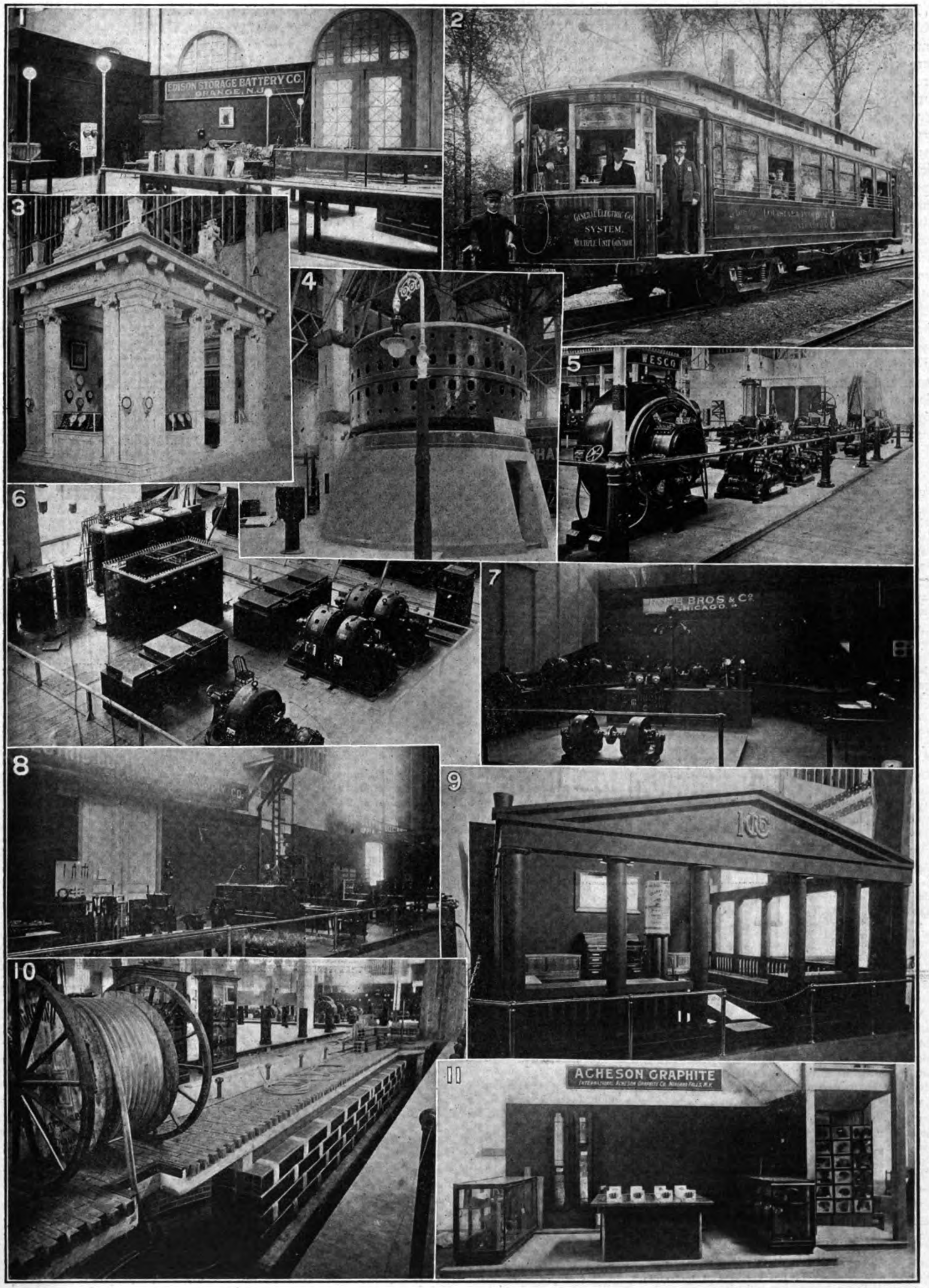
THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, has a comprehensive exhibit. Power for operating is received from a Warren synchronous motor driving a 35-kw., 220-volt Triumph generator. A Fairbanks-Morse vertical gas engine direct connected to a 7½-kw., 220-volt generator is also in use. A motor-generator receives current from this unit and converts it into current at 500 volts. A number of machine tools are shown in operation, illustrating the method of connecting the Triumph motors. A band saw is driven by a motor and intended for one speed only. A motor-driven drill is regulated by a Cutler-Hammer drum starter and controller. A Lodge & Shipley lathe is similarly equipped and in operation. All of these motors are designed for 220 volts. The machinery which forms the inoperative part of the exhibit consists of a 100-kw., multipolar, engine-type generator and a series of motors ranging in size from ½ horse-power to 25 horse-power. In order to illustrate the details of construction a large armature core is partially wound. Other detail parts are also shown.

ROTH BROTHERS & CO., Chicago, show small motors and generators which have been adapted to special lines of work. One dynamotor is used for ringing bells in telephone exchanges, with attachments for the "howler," "busy back," "automatic ringing" and "pulsating" current for party lines. Electric grinding and polishing lathes, forge blowers and motor-generator charging sets from 1-16 horse-power to 15 horse-power form interesting features of the display.

THE ELECTRIC CONTROLLER AND SUPPLY COMPANY, Cleveland, Ohio, exhibits a new system of control where the service requires frequent reversals of the driving motor under load. This control has been applied chiefly to the table motors in steel mills where a stop from full speed and an acceleration to full speed in the reverse direction of a 50-h.p. motor under load is required in less than thirty seconds. The adaptation of this system to planers is shown on a 36-in. planer, driven through one pinion and gear by a 6-h.p. variable-speed motor. The motor being direct connected is reversed at each end of each stroke of the planer. The motor is compound-wound, but the series field is only used for acceleration and is short-circuited when the motor comes up to speed. The speed of the cut and return may be varied independently and through a very wide range. The planer is shown in actual operation cutting iron and steel. Another operating exhibit is made by the company in connection with the Niles Tool Company in Machinery Hall, where a 90-h.p. electric reversing clutch operates a 12-ft. planer. A three-ton lifting magnet attached to a hoist is shown lifting steel plates and billets. Magnetic friction brakes and a cushion type of solenoid are shown in operation. The remainder of the space is filled with a line of controllers.

THE NATIONAL CARBON COMPANY, Cleveland, Ohio, has a display which is of interest not only on account of the great variety of carbons shown, but because the massive pillars and railings of the booth are of carbon made from the regular products of the company. These, for the most part, are duplicates of those used in large electric furnaces and electrolytic work.

THE STANDARD UNDERGROUND CABLE COMPANY, of Pittsburg, and the McROY CLAY WORKS, of Brazil, have a unique exhibit in the Electricity Palace. This shows on a small scale the operation of laying underground conduit and drawing lead-covered cables into the ducts. This conduit is laid under the floor at about the depth it would ordinarily be laid beneath the street surface, and the opening in the floor permits the visitor to descend by stairways and examine the conduit, which is shown in various stages on construction. There are two manholes and cable is being drawn from one to the other. The conduit consists of 72 ducts, some completely laid and some partly finished so as to show the method of wrapping the joints between lengths of tile and placing the concrete at the top and bottom of the duct. A reel of the Standard Underground Cable Company's cable, such as is used in construction work, is placed on the main floor of the building above one of the manholes, and in the manhole at the other end is a capstan rigged up for drawing in the cables. From the manholes the cables go to distributing poles, to illustrate the method of supplying overhead distribution from underground lines.


1
EDISON STORAGE BATTERY CO.
ORANGE, N.J.
2
GENERAL ELECTRIC CO.
SYSTEM.
MULTIPLE UNIT CONTROL
3
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WESCO
6
7
ROTH BROS & CO
CHICAGO
8
9
10
11
ACHESON GRAPHITE

A GROUP OF EXHIBITS AT ST. LOUIS.

1. Edison Illuminating Companies. 2. Intramural Railway Car. 3. The Bristol Company. 4. General Electric Company. 5. Triumph Electric Company 6. Sub-station. 7. Roth Brothers. 8. Electric Controller & Supply Company. 9. National Carbon Company. 10. Standard Underground Cable Company and McRoy Clay Works. 11. Acheson Graphite Company.

ACHESON GRAPHITE COMPANY, Niagara Falls, N. Y., has a space near the entrance of the building and displays miniature electric furnaces which illustrate the processes of E. G. Acheson of manufacturing graphite from anthracite coal and similar raw material. The different grades of graphite and electrodes of various sizes and forms are shown, the latter containing practical working samples of different anodes and electrodes as used by the customers of this company for electrolytic work. They illustrate the different methods of machining and assembling the graphite into economical anode forms. For electric furnace work, the electrodes can be joined together end to end into the furnace one after the other as consumed without interruption of the furnace. The graphite bulk products well illustrate the importance of this article in the manufacture of paint, dry batteries, stove polish, motor-generator brushes, etc. Special attention is given to the use of this form of pigment for high-grade productive coatings on structural iron and steel.

PERSONAL.

MR. H. C. SPAULDING has been appointed assistant sales manager of the Triumph Electric Company, Cincinnati.

MR. HARRY R. KING, the designing engineer of the Western Electric Company, of Chicago, was married recently to Miss Irene Baker, of Leadville, Colo.

MR. B. L. FREEDY, who has for many years been manager of the St. Paul system of the Northwestern Telephone Exchange Company, has been advanced to the position of superintendent, with headquarters at Minneapolis.

MR. PAUL DOTY, for several years general manager of the Denver Gas & Electric Company, has been appointed to the same position with the St. Paul Gas Light Company, which controls the St. Paul Edison Electric Light & Power Company.

MR. FRANK W. FRUEAUFF has been appointed general manager of the Denver Gas & Electric Company. Mr. Frueauff has been secretary and treasurer of the company for some time.

MR. S. P. GRACE, engineer of the Central District & Printing Telegraph Company, Pittsburg, Pa., has had the honorary degree of Master of Engineering conferred upon him by the State University of Michigan.

MR. JOHN R. CULLINANE, who has been connected with the Denison (Tex.) Lighting & Power Company for the past eighteen years, has resigned the secretaryship of that company to accept the management of the Texarkana Lighting & Power Company.

MR. CHARLES D. KNIGHT, who has been for many years well known throughout the electrical industry, has resigned his position with the National Electric Company, of Milwaukee, and joined the engineering staff of the Cutler-Hammer Company, of that city.

MR. A. L. WATERBURY, who was for some time first vice president and general manager of the Citizens' Telephone Company, Houston, Tex., has been appointed general manager of the sales department of the American Conduit Company, with headquarters at the Chicago office of that company.

MR. W. S. CONE, formerly foreman of the new steam turbine station of the Los Angeles Edison Company, has been appointed chief engineer of the American Falls Power, Light & Water Company, Pocatello, Idaho, where he has charge of extensive improvements in the steam and hydraulic equipment of that company.

MR. RALPH H. BEACH, who has been connected with the railway department of the General Electric Company about seventeen years, has severed his connection with that company and will devote his entire attention to the management of the Tula Iron Works Company, Tula, Mexico, in which he owns controlling interest.

MR. LOUIS TERVEN has been appointed chief electrician of the Nernst Lamp Company, Pittsburg, Pa. Mr. Tervan was for some time electrician at the United States Navy Yard, Port Royal, S. C., which position he resigned to enter the experimental laboratory of the Nernst Lamp Company. Later he was given charge of the Chemical Engineering Department of this company.

MR. ROBERT GREGORY recently delivered an interesting address on mechanical methods of cleaning boilers before the Keystone Association, a chapter of the National Association of Steam Engineers. Mr. Gregory is a practical engineer of many years' experience, and his paper covers the question of boiler cleaning very thoroughly. It has been reprinted in attractive form and copies may be obtained without cost upon application to Mr. Gregory at 112 Wood Street, Pittsburg.

MR. WALTER H. WHITESIDE.

MR. WALTER H. WHITESIDE has been appointed general sales manager for the Allis-Chalmers Company, including, of course, the Bullock Electric Manufacturing Company, which comprises the electrical department of the Allis-Chalmers Company. Mr. Whiteside's business experience has not been confined to the electrical field. In 1881 he became connected with the DuPont Powder Company, of Wilmington, Del., and introduced the high explosive products of that company into the Lake Superior region. Four years later he became associated with the Cleveland Electrical Manufacturing Company, of Cleveland, Ohio. He remained with that concern nearly twelve years, serving during the first two years in various capacities, and for the remainder of the time being the manager of their Chicago office. In 1896 Mr. Whiteside was appointed manager of engine sales for the Gates Iron Works, of Chicago. In 1898 the Westinghouse Electric & Manufacturing Company made him the manager of its Washington office. In that position he became associated not only with the largest electrical projects undertaken in the district which his office covered, but in other places farther afield, his engineering work in connection with the installation of electrical power in the Dry Docks of the Navy Department, especially the docks at Portsmouth, League Island and Boston, having been widely recognized. To him was largely due the credit of the change from 80 to 125 volts in the electric lighting and power installations on board the vessels of the U. S. Navy But Mr. Whiteside's best work in the commercial sense was the building of that immensely successful branch of the Westinghouse Electric organization known as the Detail & Supply Department. Into this department he injected a new life and vigor of administration that won for him recognition for marked executive ability. About a year ago he was appointed general manager of the Sawyer-Man Electric Company, of New York, thereby practically doubling his duties, for he continued the management of the Detail & Supply Department of the parent company at Pittsburg. Mr. Whiteside is a man of force and also of attractive personality. He would be a strong man for any industrial concern, and it is difficult to know whether to congratulate the more the Allis-Chalmers Company, which has secured his services, or himself for becoming identified with that powerful concern.

MR. R. M. JONES, for the past five years chief engineer and general superintendent of the Pike's Peak Power Company, Victor, Colo., has severed his connection with that company to engage in consulting engineering. Mr. Jones is prepared to take up any work in connection with hydraulic and electric plant construction or design or as consulting engineer or supervising constructing engineer. His experience in hydraulic-electric work in the West qualifies him admirably for this class of engineering. His present address is 1455 Josephine Street, Denver, Colo.

MR. A. M. MATTICE, chief engineer of the Allis-Chalmers Company, has returned from his European tour of inspection, and has now settled down to the duties of his position in Milwaukee. While in Europe Mr. Mattice visited the hydraulic machinery works of Escher, Wyss & Company, of Zurich, and arranged important details concerning the manufacture in the United States of their lines of product. He also inspected the Nurenberg Gas Engine Works, at Nurenberg, and, at the well-known engineering establishment of Willans & Robinson, at Rugby, England, he paid particular attention to the products and methods of manufacture of the Steam Turbine Advisory Syndicate, of which important organization the Allis-Chalmers Company is the American member. Mr. Mattice had several important consultations in London with Mr. Yarrow, the famous torpedo boat builder, on the subject of turbines for marine purposes, and while on the Continent he made, in the Allis-Chalmers interests, a series of exhaustive tests of the Zoelly steam turbine, of which so much has recently been heard.

TRADE PUBLICATIONS.

INSULATING MATERIALS. H. W. Johns-Manville Company, New York.—A pocket size pamphlet, comprising a complete price-list of standard mica, oiled linen, Vulcabeston, and other insulations.

RECORDING PRESSURE AND VACUUM GAUGES. The Bristol Manufacturing Company, Waterbury, Conn.—Catalogue No. 13 of the well-known Bristol recording meters for vacuum and pressure work.

GAS ENGINE GENERATOR UNITS. The Meriam-Abbott Company, Cleveland, O.—A small, well-executed pamphlet, containing illustrations and a brief description of the gas engine-dynamo units built by this company.

MULTIPLE-VOLTAGE MOTOR SPEED CONTROL. The Bullock Electric Manufacturing Company, Cincinnati.—Bulletin No. 1028, superseding bulletin No. 1009-A and devoted to the well-known Bullock multi-voltage system.

GUARANTEED TELEPHONES. Electric Gas Lighting Company, Boston, Mass.—A vest pocket pamphlet, containing illustrations and brief descriptions of the Samson and Samson, Jr., telephone outfits manufactured by the E. G. L. Company.

HIGH-TORQUE INDUCTION METERS. General Electric Company.—Bulletin No. 4379, containing an illustrated description of the Thomson high-torque induction type of meter. These meters are built for the standard voltages and frequencies.

MACHINE TOOLS. The Garvin Machine Company, New York.—A pocket size catalogue of drill presses, engine lathes, planers, shapers, presses and grinding machinery carried in stock by the Garvin Company at its New York warehouse.

TYPE H TRANSFORMERS. General Electric Company.—Publication No. 9132, superseding publication No. 9144 and containing an illustrated discussion of the Type H oil-cooled transformer. The pamphlet is handsomely executed and profusely illustrated.

AIR COMPRESSORS. National Electric Company, Milwaukee, Wis.—Bulletin No. 350, containing an illustrated description of this company's Type H and Type L motor-driven air compressors. The catalogue is handsomely executed and liberally illustrated.

ELECTRICAL SUPPLIES. Manhattan Electrical Supply Company, New York.—This is catalogue No. 18, covering the complete aggregation of apparatus and supply lines manufactured and handled by this company. The number of lines covered by the catalogue is too great for enumeration.

MOTOR-DRIVEN BLOWERS. The Emerson Electric Manufacturing Company, St. Louis.—Bulletin No. 3055, containing a description and illustrations of motor-driven forge and volume blower fans. The motors are the well-known Emerson direct-current machines, built for all the standard voltages.

DIRECT-CURRENT GENERATORS. The Bullock Electric Manufacturing Company, Cincinnati. —Bulletin No. 1029, superseding No. 1008 and containing a profusely illustrated description of the Bullock engine-type direct-current dynamos. The bulletin is well executed and the description interesting.

AUTOMATIC STEAM ENGINES. The Buckeye Engine Company, Salem, O.—This is a handsome catalogue containing a very complete description of all of the types of Buckeye engine. These engines are now built in the vertical as well as horizontal types and in both center-crank and side-crank forms.

GENERATING PLANT OF THE INTRAMURAL RAILWAY. Crocker-Wheeler Company, Ampere, N. J.—This is bulletin No. 47, devoted to the electrical equipment of the Intramural Railway power house at the St. Louis Exposition. The equipment consists of seven Crocker-Wheeler generators, each of 750 kilowatts capacity.

COMMUTATOR GRINDER. The Phillips Machine Syndicate, Ltd., London.—A catalogue of the Phillips patent commutator grinder, which differs radically from all of the portable or semi-portable machines commonly used in this country for trueing commutators in that the work is done by grinding instead of by means of an ordinary lathe tool.

INTERIOR TELEPHONES. Electric Gas Lighting Company, Boston, Mass.—Bulletin No. 1, the full title of which is "The Specializing of Interior Telephone Apparatus." The bulletin is in reality a very complete and handsomely executed catalogue of Samson and Samson, Jr., telephones, and contains illustrations not only of the outfits, but of every individual piece of mechanism contained in each outfit.

DYNAMO AND MOTOR APPLICATIONS. Northern Electrical Manufacturing Company, Madison, Wis.—A series of fliers, comprising leaflets Nos. 120-A, 121, 128, 130 and 131, each containing an illustration of a Northern dynamo or motor and the machine with which it is operated. The leaflets show dynamos driven by gas engines and steam engines and motors driving different classes of machinery.

BUSINESS NEWS.

JAMES McCREA & COMPANY, Chicago, have appointed Braman, Dow & Company, Boston and Worcester, Mass., agents for the sale of the H. H. steam trap.

H. W. JOHNS-MANVILLE COMPANY, New York, has secured the contract for equipping the new residence of Louis C. Tiffany with Noark fuses and magnesia pipe covering.

PASS & SEYMOUR, INC., of Solvay, N. Y., report large sales of their new fuseless rosette for concealed wiring installations. Each sample sent out makes a friend and produces orders.

THE NATIONAL WIRE CORPORATION, of New Haven, Conn., on August 1 removed its general and executive offices from New Haven to New York City. The address is 114 Liberty Street.

THE KEYSTONE LUBRICATING COMPANY, Philadelphia, manufacturer of the well-known Keystone grease, has appointed Herbert Carpenter general agent for Boston and the vicinity.

CROUSE-HINDS COMPANY, Syracuse, N. Y., through F. M. Hawkins, New York agent, reports the recent shipment of 180 Imperial headlights to Dick, Kerr & Co., London, for use in a plant at Yokohama, Japan.

THE MERIAM-ABBOTT COMPANY, Cleveland, Ohio, has on exhibition at the St. Louis Exposition an 18-h.p. gas engine-generator unit which is located in the exhibit space of the Ewing-Merkle Electric Company, St. Louis representative.

WESTON ELECTRICAL INSTRUMENT COMPANY, Newark, N. J., has made an arrangement with the Cutter Company, of Philadelphia, whereby the latter company is to sell the well-known Weston central station instruments.

CROCKER-WHEELER COMPANY, Ampere, N. J., has arranged with the well-known manufacturing establishment of Brown, Boveri & Cie., Baden, Switzerland, to manufacture in this country the complete alternating-current line of machinery originated by C. E. L. Brown.

THE VILTER MANUFACTURING COMPANY, Milwaukee, Wis., reports a heavy trade in refrigerating machinery. A list of contracts recently closed includes 22 refrigerating plants, 8 Corliss engines and 23 orders for ammonia condensers, piping, and other fittings for refrigerating plants.

THE PITTSBURG GAGE & SUPPLY COMPANY, Pittsburg, Pa., reports among recent orders for White Star oil filter systems, equipments for the Carnegie Steel Company, Homestead, Pa., Nashville (Tenn.) Railway & Light Company, Allegheny City Lighting Station, and the Harris Steam Engine Company, Providence, R. I.

MORE WESTINGHOUSE APPARATUS FOR SOUTH AFRICA. The De Beers Mines Company, of Kimberly, South Africa, has ordered a third Westinghouse turbine-generator of 1500 kilowatts capacity. The turbine unit will be similar in all respects to the two which have been in operation during the past year.

THE D. & W. FUSE COMPANY, Providence, R. I., is particularly gratified over the closing of a large contract for cut-outs and fuses for the Manhattan elevated system of New York. The order was secured entirely on merit, after subjecting the D. & W. fuses to severe tests in competition with those of other makers.

THE WESTINGHOUSE COMPANIES invite the electrical fraternity at large to visit their headquarters in the Palace of Electricity, Machinery and Transportation at the St. Louis Exposition. The companies have extensive exhibit spaces in all three buildings, and attendants are, of course, at hand to welcome visitors and do what is necessary for their comfort.

BROWN-CORLISS ENGINE COMPANY, Corliss, Wis., at a recent meeting of the stockholders, voted to increase its working capital $150,000. The company has just established a department for building high-speed engines and is now at work on two 150-h.p., three 250-h.p., one 75-h.p., and two 50-h.p. engines, all of which are to be direct-connected to electric generators.

THE JONES ELECTRIC & MANUFACTURING COMPANY, of New York, has been incorporated under the laws of the State of New York with a capital stock of $50,000 for the purpose of manufacturing telegraphic instruments, apparatus and supplies. The officers are S. F. Jones, president; F. G. Smith, vice-president, treasurer and general manager; H. H. Sherman, secretary, and C. Wachtel, superintendent.

ALLIS-CHALMERS COMPANY, Milwaukee, extends a cordial invitation to visitors to the St. Louis Exposition to make use of the facilities provided at its Exposition space in Machinery Building. Visitors will find here a comfortable resting place, writing tables, stationery, and attendants who will receive and forward mail and telegrams, check parcels, and do all that is possible for the comfort of visitors, without charge, of course.

ELECTRICAL EQUIPMENT & SUPPLY COMPANY, Pittsburg, Pa., has obtained the representation in Western Pennsylvania of the Gilmore Electric Company and the Electric Gas Lighting Company, of Boston, Mass., and will represent the lines of those companies exclusively in the territory mentioned. The company has recently put on the market the "Esco" dry battery, "Esco" wet battery, and "Esco" soldering paste, all of which are meeting with very gratifying success.

THE REEVES ENGINE COMPANY, New York and Trenton, has established a branch office at Philadelphia, under the management of W. E. S. Dyer. The Philadelphia office is located at 2220 Land Title Building. The company recently installed in its factory at Trenton what is said to be the largest cylinder boring machine ever built in this country. The machine weighs 35 tons, and is to be used for boring engine cylinders and engine frames. It is capable of boring four cylinders simultaneously. Among the company's recent sales was an engine to the Diamond Rubber Company, Akron, Ohio, for connection to a 150-kw. generator; also one vertical cross-compound to the Brier Hill Iron & Coal Company for direct-connection to a 250-kw. generator.

G. M. GEST, the well-known subway contractor of New York and Cincinnati, was awarded recently a contract for the construction of a heavy 20-duct conduit system through Cincinnati, leading from the new exchange to the Fremont Avenue exchange of the Cincinnati Bell Telephone Company. Mr. Gest has also been awarded a large contract for the construction of a conduit system through the lower part of Brooklyn, leading from the new power house of the Brooklyn Heights R. R. Company to its new sub-station. He has also closed contracts for the construction of an extension to the subway system of the Brooklyn Edison Company for a conduit system to be installed by the Oliver Chilled Steel Plow Works, South Bend, Ind., and for conduits systems for the South Bend (Ind.) Electric Company and the Toronto (Ont.) Street Railway Company.

ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, recently closed contracts for installations of "Chloride" accumulators for the following railways: Long Island Railroad Company, at Hamil, L. I.; Portsmouth, Dover & York Street Railway, Dover, N. H.; Petaluma & Santa Rosa Electric Railway, of California; Toledo (Ohio) Railways & Light Company, and the City Railway Company, Dayton, Ohio. Contracts have also been closed for batteries for lighting and power service with the Mutual Life Insurance Company, New York, and the Central Oil & Gas Stove Company, Gardner, Mass.; Westinghouse, Church, Kerr & Company have ordered over 2000 cells of "Chloride" accumulators for use in train lighting on the New York, New Haven & Hartford railroad, and over 600 cells have been ordered for the Atchison, Topeka & Santa Fe Railway Company for signal service. Increases have been made in the plants of the Lancaster (Ohio) Traction Company, the Denver, Champaign Railway Company, St. Joseph, Ill., the Danville Street Railway & Light Company, Georgetown, Ill., and the Rochester (N. Y.) Railway & Light Company.

THE BIG ALLIS-CHALMERS ENGINE AT ST. LOUIS.—The central feature of the machinery exhibits at the World's Fair in St. Louis is the huge Allis-Chalmers engine coupled to a Bullock generator. This colossal unit is the most powerful ever placed on exhibition. The engine is capable of developing 8000 horse-power when operating condensing, at 150 pounds steam pressure, and running at 75 r.p.m. It is not merely a display feature: it furnishes the electric current for the decorative lighting of the buildings and grounds, for which about 200,000 incandescent lamps are used. The exhibition authorities frequently employ it for other purposes as well, sometimes for operating the cascades and sometimes for general power purposes. Recently it was suddenly called upon to take the entire load ordinarily carried during the day by a large plant in the same building, and aggregating about 5400 horse-power. Having carried this load as long as it was needed, the Allis-Chalmers giant then took up the regular lighting work for the evening The St. Louis Transit Company, which operates the larger part of the street car system in St. Louis, has been short of power many times since the World's Fair began to attract large numbers of visitors, and the company applied to the World's Fair authorities for additional power, with the result that from 2 P. M. until 7 P. M., when the loads are heaviest, the service of the big Allis-Chalmers engine is at the service of the traction company.

CENTRAL STATION NEWS

ALABAMA.

LUVERNE.—City Clerk A. B. Brooks writes that it is proposed to construct water works and an electric light plant here to cost $10,000.

BIRMINGHAM.—Extensive improvements are now under way at the plant of the Birmingham Railway, Light & Power Company. These include new boilers and a new 1500-kw. alternator.

EAST LAKE.—A franchise has been granted to the Birmingham Railway, Light & Power Company for the installation of an electric light system in East Lake.

SHEFFIELD.—The Sheffield Company has begun the work of erecting the poles for the new electric light system which is to be installed here and will push the work to completion as rapidly as possible.

PRATT CITY.—Several arc lights have been placed in the business portion of the city by the Birmingham Railway, Light & Power Company. It is proposed to have lights placed all over the city in the near future.

CHEROKEE.—Plans have been perfected by the Cherokee Development & Mining Company for the construction of a 25,000-h.p. plant on the Tallapoosa River at this place. The power thus developed will be transmitted to Birmingham, 85 miles distant, for the purpose of augmenting the 100,000 horse-power already in use there. The main dam will be 100 feet high and constructed of granite. The plant when completed, including the long transmission line, will represent an investment of $2,000,000. Mr. Henry C. Jones, of Montgomery, is engineer for the company.

ARIZONA.

TUCSON.—The Consolidated Telephone, Telegraph & Electric Company has filed articles of incorporation with a capital of $2,500,000. The company proposes to furnish current for lighting and power purposes and will expend a large amount in improvements and extending its lines to Old Mexico. The company's headquarters will be in this city.

ARKANSAS.

GRAVETTE.—An electric light plant is soon to be established here.

NASHVILLE.—It was recently voted by the citizens fo construct an electric light plant and water works.

WALNUT RIDGE.—The Walnut Ridge & Hoxie Light, Power & Traction Company has in contemplation the construction of three-quarters of a mile additional street railway track. Mr. Charles Miller is superintending the plant.

MAGNOLIA.—Mr. E. A. Brown, of the Magnolia Ice & Light Company, writes that bids will be received at once for the construction of an electric light plant which will probably cost about $25,000.

EARLE.—Mr. H. A. Morrison, secretary of the Earle Improvement Company, writes that bids for the construction of water works, a sewerage system and an electric light plant will not be called for in two or three months. The cost has not yet been estimated and no engineer has been engaged.

NORTH LITTLE ROCK.—A petition has been submitted to the Council by the property owners in this city for the construction of water works and an electric light plant.

CALIFORNIA.

ANGELS CAMP.—The Angels Electric Company is now owned and operated by the Utica Gold Mining Company.

HEALDSBURG.—Preparations are being made toward the establishment of an electric light and power plant at this point.

EUREKA.—The plant of the Eureka Lighting Company was destroyed by fire a short time ago. The loss is estimated at from $60,000 to $100,000.

SACRAMENTO.—The Sacramento Electric, Gas & Railway Company is installing a new switchboard and arranging to extend its distribution lines.

LOS ANGELES.—Mr. John Johnson, Jr., representing Los Angeles capitalists, has petitioned for franchises for gas and electric light plants at Oceanside and Escondido.

SAN BENITO.—The San Benito Water, Light & Power Company has been incorporated by Messrs. L. A. Gibbons, A. I. Little, G. T. Drinkwater and others, with a capital of $300,000.

CORONA.—The Corona Gas & Electric Company recently issued bonds to the amount of $40,000 for the purpose of meeting its indebtedness and to enable it to complete and extend its plant.

SONORA.—The Tuolumne Water & Power Company, of this city, has decided to extend its power transmission line from Jacksonville to Big Oak Flat and Groveland. Mr. J. B. Pownall is superintendent and purchasing agent.

LOS ANGELES.—The equipment at the plant of the Los Angeles Gas & Electric Company is being increased by the addition of a 300-kw., 500-volt, direct-current, direct-connected engine-generator set and 1000-h.p. Stirling boilers.

MERCED.—The Merced Falls Gas & Electric Company is installing new machinery and making additions which will double the capacity of its power plant. A new 225-kw. generator with exciter has been ordered and the buildings are being enlarged.

BLACK DIAMOND.—Application has been made by the Redwood Manufacturing Company for a franchise authorizing it to erect poles along the streets here to carry wires for the transmission of electric heat and power throughout the town. Bids were received for the franchise on May 17.

OAKLAND.—Articles of incorporation of the Century Electric Company of Alameda County have been filed with the County Clerk. The directors are Messrs. F. M. Greenwood, C. M. Wood, E. H. Weihe, John P. Maxwell and R. C. H. Hartley. The capital stock of the corporation is $50,000.

FRESNO.—The San Joaquin Power Company is said to be figuring on two more water power plants in the mountains and will probably put in 1500 kilowatts additional steam power at its plant in Fresno. The company also contemplates building additional pole lines from Fresno to its power house sites, a distance of 36 to 40 miles.

LOS ANGELES.—Mr. W. S. Cone, formerly foreman of the new steam turbine station of the Edison Electric Company of Los Angeles, has accepted a position as chief engineer of the American Falls Power, Light & Water Company, of Pocatello, Idaho, and has charge of some extensive steam and hydraulic improvements for that corporation.

SAN FRANCISCO.—The Mutual Electric Light Company, of this city, has broken ground at the site of its new electric generating station at the corner of Spear and Folsom Streets. Two 1500-kw. Bullock polyphase generators are on hand which will be direct-connected to two Pennsylvania Iron Works horizontal engines. The boiler contracts are to be let soon, in order to have the new plant installed in time to help out the old station with the "peak" load of next winter.

SAN FRANCISCO.—The public lighting contract for the year beginning July 1 has been awarded to the San Francisco Gas & Electric Company for $320,000 on an all-night schedule every night in the year. The contract provides for 1112 arc lamps, 5335 Welsbach gas lamps, the illumination of the dome of the City Hall on twelve nights, the lighting of all public buildings except park and school buildings, and the furnishing of power for elevators. The company also agrees to install 100 new arc lamps and 200 new gas lamps.

MENDOCINO.—The Mendocino Electric Light & Power Company, which recently took over the plant of the Mendocino Lighting Company, is making improvements at the plant, putting in new line extensions, etc. The company is capitalized at $25,000 and is officered as follows: President, Mr. J. Grindle; vice-president, Mr. J. G. Ross; secretary, treasurer and manager, Mr. A. Brown; superintendent, chief engineer and electrician, Mr. J. W. Heap. Besides Mendocino, the company's plant furnishes electricity for lighting the towns of Caspar, Little River and Albion.

LOS ANGELES.—Mr. O. H. Ensign, electrical and mechanical engineer of the Edison Electric Company of Los Angeles, has been appointed consulting electrical engineer of the U. S. Reclamation Commission, and is now on a trip of two months through the states of the arid West in company with Chief Engineer Newell, of the Commission. Mr. Ensign will investigate and report on the feasibility of hydro-electric power development in connection with the many hydraulic works which the Commission has under way and in contemplation, a task for which he is especially qualified by reason of his long and successful experience in developing the water power plants of the Edison Electric Company, with which he retains his connection.

COLORADO.

DENVER.—Mr. Frank W. Frueauff has been appointed general manager of the Denver Gas & Electric Company.

CONNECTICUT.

MERIDEN.—The Meriden Electric Light Company is installing a direct-connected unit consisting of a 380-h.p. Westinghouse engine and a 200-kw. generator.

NORWICH.—The council expects to make extensive improvements at the city plant which has recently been acquired by the city from the Norwich Gas & Electric Light Company. Bonds to the amount of $235,000 were issued by the council for the purchase of the plant and property.

NORFOLK.—The amount of $10,000, which was to be raised by the Norfolk people in order to reorganize the Norfolk Electric Light & Power Company, has been secured and the new company will be organized as soon as possible. It is probable that the streets of the village, which have been without lights for nearly two months, will be lighted again in the near future.

NORWALK.—Mr. William J. Burr has resigned his position as superintendent of the electric light department of the Connecticut Railway & Lighting Company. Mr. Burr had been connected with this company and its predecessor for over twelve years; for five years of that time he was superintendent of the system, which also included the electric lighting and power house on Wilton Avenue. It is understood that Mr. Burr has received a very flattering offer elsewhere.

CHESHIRE.—The large electric transformer station of the Connecticut Railway & Lighting Company in this place is now completed and in a short time all electric cars in this section will be propelled by power transmitted from the dynamos at Bull's Bridge near New Milford. These dynamos are operated by water-power obtained by means of a dam on the Housatonic River. Power is transmitted from the Housatonic power house to Cheshire over a high-tension line at 30,000 volts, where it is stepped down to 500 volts before being

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

distributed to the trolley lines. Besides the transformers, the equipment of the station includes three large rotary converters and a "booster." The total output of the station is about 1800 horsepower. The plant is housed in a brick and iron building 140x100 feet. The route of the transmission line is from Bull's Bridge to Waterbury and thence through Cheshire to New Britain, a distance of 60 miles.

FLORIDA.

WEST PALM BEACH.—The work of building the new boiler house and installing the 200-h.p. boiler at the plant of the East Coast Electric Light, Power & Ice Company has been completed. The installation of the new boiler will double the boiler capacity of the plant, which has been handicapped heretofore by lack of power.

TAMPA.—One of the most important and far-reaching movements in the industrial development of southern Florida is now practically under way. The waters of the Withlacoochee River are to be harnessed and electric power generated for the operation of the large phosphate plants and mills in Citrus, Marion and Levy Counties. The Camp Phosphate Company will at once begin the construction of the great dams on the river near this point. It will not only supply power for its own plants and mills, but for other corporations and manufacturing establishments, and electric lighting for adjacent towns and cities.

GEORGIA.

OCILLA.—The Council is considering the matter of constructing an electric light plant.

LA GRANGE.—An election is to be held soon for the purpose of voting on the question of issuing $25,000 bonds for the erection of an electric light plant.

LOUISVILLE.—A bond issue of $10,000 has been voted by the citizens, the amount to be devoted to constructing water works and an electric light plant.

BATESBURG.—It was voted at a recent election to bond the town for $20,000 for the purpose of establishing an electric light plant, water works, and other permanent improvements.

STILLMORE.—An electric light plant is to be installed here, the enterprise being backed by home capital. The work of stringing the wires is now in progress and the plant will be put in operation as soon as possible.

WALLACOOCHEE.—The Town Council has prepared a bill to be introduced in the Legislature, authorizing the issuance of $10,000 bonds for public improvements, consisting of a new school, an electric light plant and a water works system.

GAINESVILLE.—The big dam of the North Georgia Electric Company, which has been in course of construction on the Chattahoochee River near this city for nearly two years, has just been completed. Mr. E. S. Copeland has recently been elected secretary of the company.

ELBERTON.—The indications are that the Calhoun water power on the Savannah River, near this city, will soon be developed, as parties have been on the field to abstract titles. Application will be made to the next Legislature for the right to dam the river at a point twelve miles from here.

MACON.—A petition for a charter for the Piedmont Power Company has been made by Messrs. Robert L. McCabe, F. M. Marriatt, William A. Carlisle and Charles F. Howe. It is their purpose to organize a company with a capital of $2,000,000 to utilize the water power of Georgia and neighboring states. The headquarters of the company will be in this city.

IDAHO.

WHITE BIRD.—The electric light plant here is to be enlarged.

BOISE.—The Crane Falls Power & Transportation Company has been incorporated for the purpose of constructing an electric power plant at Crane Falls, Owyhee County, the power generated to be used for the operation of the company's several plants. Among the directors are Messrs. William B. Dean and A. J. Nathacker, New York; Messrs. B. F. Olden and L. J. Weaver, of Boise, and others. The company is capitalized at $5,000,000.

MOSCOW.—Mr. E. S. Aldrich, vice-president and manager of the Moscow Electric Light & Power Company, states that a contract has just been closed with the Lewiston Water Power Company for power furnished by that company. He writes that his company is preparing to install sub-stations and distributing plants in this city and Genesee, Idaho, and Pullman and Uniontown, Wash., for the supply of power and light on a 24-hour circuit; it is probable that $2,500,000 will be expended in improvements and enlargements during the next five years.

POCATELLO.—The Bonanza Land, Power & Light Company was recently consolidated with the American Falls Power, Land & Light Company. The officers of the corporation, which is capitalized at $2,000,000, are Mr. A. H. Tarbet, president; Mr. J. H. Brady, general manager; Mr. D. W. Stanrod, treasurer, and Mr. W. S. Chaney, secretary. The consolidation gives the company 25,000 horse-power and practical control of the electric business of southeastern Idaho. Most of the power will be secured from American Falls. It is expected that eventually the company will extend its lines to Butte, Mont., for the purpose of supplying power to the mines there.

ILLINOIS.

SAYBROOK.—An electric light system is to be installed here soon.

SENECA.—The trustees of the town have decided to light the city by electricity.

STREATOR.—The People's Light & Railway Company is engaged in erecting a new power house.

WOODHULL.—The Woodhull Electric Light Company expects to install a new dynamo shortly.

ALEXIS.—It has been voted by the citizens to purchase the electric light plant here and operate it as a municipal plant.

WALNUT.—The plant of the Walnut Electric Light Company is now owned and operated by Messrs. W. H. Sayles and C. Dunbar.

GIBSON CITY.—Messrs. A. L. Phillips and L. J. Hiland, with others, have incorporated the Gibson Electric Light & Power Company, which is capitalized at $30,000.

CHICAGO.—The Universal Electric Company has filed articles of incorporation with a capital stock of $2500. Messrs. C. J. Holland and N. F. Higgins are among the directors.

CARTHAGE.—The Carthage Electric Light & Heating Company is putting in a new boiler equipment at its plant and is also contemplating the erection of a central heating plant.

HILLSBORO.—A franchise has been granted to the Hillsboro Electric Light & Power Company to erect and maintain electric light wires over the highways of the county for the purpose of extending its system.

GILLESPIE.—The Gillespie Electric Light Company has been incorporated, with a capital of $15,000, to maintain an electric light and power plant. Messrs. E. W. Gillett and N. E. Schmidt are among the directors.

LITCHFIELD.—Improvements are under way at the plant of the Litchfield Gas & Electric Company. New machinery is being installed, consisting of a 200-h.p. engine and boiler and a 150-kw. single-phase 1100-volt alternator.

PARIS.—The City Gas & Electric Company has filed articles of incorporation for the purpose of operating a gas and electric light plant. The capital is fixed at $150,000 and Messrs. A. J. Barber, W. J. Hunter and J. E. Parrish are the incorporators.

CARROLLTON.—Messrs. Robert H. Bigger, F. M. Sinsabaugh and W. D. Moore recently filed articles of incorporation for the Carrollton Heat, Light & Power Company, placing the capital stock at $5000. The company is organized to operate heat, light and power plants.

MORRISONVILLE.—The Morrisonville Electric Light Company, formerly owned by T. E. Cloyd & Son, has been incorporated under the style of the Morrisonville Electric Company. The capital stock of the company is placed at $6000. Messrs J. D. Lewis and T. E. Cloyd are among the directors.

RIDGEFARM.—The plant of the Ridgefarm Electric Light, Heat & Power Company, which was recently destroyed by fire, is to be rebuilt by Messrs. Henderson & Linn. Mr. W. Henderson was superintendent of the old plant. The old engine, which was damaged somewhat by the fire, is being repaired and orders have been placed for a new dynamo and a 150-h.p. boiler.

CARBONDALE.—The Carbondale Lighting Company has been consolidated with the Carbondale Water Works Company under the style of the Carbondale Water, Light & Power Company. The company has a capital of $200,000 and its officers are as follows: President, Mr. E. M. Kellogg; secretary, Mr. F. Mason; manager and purchasing agent, Mr. G. C. Campbell; superintendent, Mr. D. Fraser.

CHICAGO.—A proposition is being discussed whereby the city will receive the current to be generated by the water in the drainage canal at Lockport. Commissioner of Public Works Blocki states that 25,000 horse-power would supply an arc light for every street intersection in the city, which would be about three times the present number, and if the city can obtain this power the additional lights will be installed. The principal question under discussion is whether the power shall be given to the city at cost or whether a reasonable price shall be charged for it.

ALTON.—The merger of the Alton Light & Traction Company and the Granite City Electric Street Railway Company, which has just been effected, will unite several hundred miles of street railway and will connect Alton with St. Louis and intermediate points. The work of connecting the two systems of railways will be commenced at once. A proposition is being considered for increasing the capital stock of the two companies from $1,000,000 each to $3,000,000 jointly. The officers of the consolidated company are as follows: Mr. J. F. Porter, president; Mr. F. E. Allen, vice-president; Mr. C. A. Caldwell, secretary; Mr. J. H. White, superintendent. Lighting current will also be furnished to Upper Alton and North Alton, as heretofore.

CHICAGO.—On July 1 the City Council passed an ordinance providing for the issue of $5,000,000 bonds to be used for public improvements. Of this amount, about $1,750,000 has been appropriated for the extension of the electric light plant, bridges, fire and police stations, and other public work. Bids have been asked for by the City Electrician for furnishing and installing, where specified, the following for the use of the Department of Electricity: Two vertical cross-compound condensing engines of 1000 horse-power each, four water-tube boilers, three mechanical stokers and smoke consuming devices, mechanical induced draft apparatus, turbo-generator and direct-connected units and accessories, and 500 alternating-current enclosed-arc lamps.

INDIANA.

LEBANON.—A proposition to install an electric light plant here is being considered by the city.

KNOX.—Mr. Thos. A. Grist recently purchased the plant of the Knox Electric Light & Power Company.

MARTINSVILLE.—Plans are being prepared for a new brick power house for the Martinsville Light, Heat, Water & Power Company. The power house will be 50 ft. x 100 ft.

FORT WAYNE.—The Wayne Water Power Company has been incorporated with a capital of $100,000. Messrs. John H. Bass, John W. White and William A. Fleming are the directors.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

BERNE.—Articles of incorporation have been filed by Mr. H. H. Stucky, H. S. Michand and others, for the Berne Electric Light Company, in which the capital of the company is stated to be $6000.

JASPER.—Electric light bonds to the amount of $12,000 have been sold, and the contract for the power house and pumping station for an electric light plant and water system has been awarded to Schmidt & Renner, of this city.

ELKHART.—The Elkhart City Power Company has been incorporated by Messrs. C. G. Conn, P. L. Turner and W. I. Gronert, with a capital of $50,000. The company has been awarded the city lighting contract for ten years from August 1, 1904.

TERRE HAUTE.—Work on the new power house of the Terre Haute Electric Company is progressing and the boiler house is nearly ready for the installation of the three 520-h.p. boilers built by the Aultman & Taylor Company, Mansfield, Ohio.

MUNCIE.—Recent reports are to the effect that the plant of the Muncie Electric Light & Steam Heating Company has been purchased by The Electric Company of America. It is also stated that $150,000 will be expended in improving the property on North Walnut Street.

MARION.—The direct-current system now in use at the municipal lighting plant is to be replaced by a series alternating-current system. An alternating-current Westinghouse alternator is to be installed, also series enclosed arc lamps which will be run on four 75-light circuits. Mr. Otis Weesner is superintendent of the plant, and Mr. Charles A. Lower is chief engineer.

OXFORD.—The City Council is figuring on lighting two other small towns with electricity supplied by the municipal plant, one town being five miles and the other eight miles distant. In case the matter is acted upon favorably, a step-up transformer will be used for the most distant town with a transmission voltage of 6600 volts. Mr. H. E. Frost is now superintendent and chief electrician of the city lighting plant.

CRAWFORDSVILLE.—Some rather extensive changes are being made at the plant of the Crawfordsville Electric Light & Power Company. Larger units are being installed in the power house and the company is changing from 133 to 60-cycle circuits. The line wires now in use will also be displaced by wires of larger size. Mr. Spencer Stucky is chief engineer of the company.

ELKHART.—Mr. George R. Martin, who was formerly engineer at the power house of the Home Electric Company and who has filled various positions since he left here in 1900, has been appointed chief engineer of the Grand Falls plant of the Southwest Missouri Light Company, of Joplin, Mo. Mr. Martin resigned his position as superintendent of the New Albany (Ind.) water works to accept his present position.

BLOOMFIELD.—The Bloomfield Light, Heat & Power Company has been reincorporated and is now known as the Home Light & Water Company. The officers of the company, which is capitalized at $10,000, are as follows: President, Mr. R. B. Dugger, who is also manager and superintendent; secretary, Mr. John C. Gilliland; chief engineer, Mr. A. A. Howard, and chief electrician, Mr. E. H. Dugger. The company has the city lighting contract on a midnight schedule.

INDIAN TERRITORY.

COMANCHE.—The Comanche Electric Company, owned and operated by Diehl & Schneider, has been awarded the city lighting contract.

TULSA.—The Tulsa Water, Light, Heat & Power Company, of which Mr. John Dermott is president, has been incorporated with a capital of $120,000, and will proceed at once with the construction of its plant.

WAGONER.—The following are the officers of the Wagoner Light & Power Company: Mr. T. A. Parkinson, president; Mr. J. D. Brazell, vice-president; Mr. T. C. Harrill, secretary, manager and superintendent; Mr. H. E. Dodge, treasurer; Mr. S. D. Camp, chief engineer; Mr. C. E. Kapp, chief electrician.

IOWA.

PELLA.—The City Council may install a new electric light plant.

DUBUQUE.—The Union Electric Company proposes to extend its lines.

GREENE.—A project is on foot to organize a company to purchase a lighting plant.

HARLAN.—Mr. George W. Cox is now superintendent of the city electric light plant.

MOULTON.—Mr. L. L. Corey is chief engineer of the Moulton Electric Light Company.

HAWARDEN.—The electric light plant is to be extensively repaired at a cost of about $6000.

ORANGE CITY.—Mr. L. H. Slikkerveer is chief engineer of the Orange City Electric Light Company.

ROCK ISLAND.—Reports state that $5000 will be expended in improvements at the municipal lighting plant.

RICEVILLE.—The Riceville electric light plant is now owned by a stock company, of which Mr. Robert Templeton is secretary and manager.

AFTON.—The town authorities are planning to have the municipal lighting plant given a thorough overhauling. Mr. F. J. Spencer is manager.

BOONE.—The construction of a municipal electric lighting plant is being considered by the Town Council. It is estimated that the plant will cost $20,000.

SIOUX RAPIDS.—A committee has been appointed to secure the lowest price on the present electric light plant, which is owned by Mr. W. E. Brown, and also to ascertain the expense of putting in an entirely new one.

ROCK RAPIDS.—The City Council has decided that it is impracticable to rebuild the electric light plant this season. It will cost nearly $5000 to repair the present plant, using the same system, and it was deemed best to wait another year and install a modern system.

DES MOINES.—Recent reports state that the Iowa Light & Heat Company contemplates the construction of heating plants in University Place and on Pleasant Street, near Woodland, this fall, for which purpose an effort is being made to increase the capital about $50,000.

KANSAS.

ELDORADO.—Mr. W. M. Jones, of Rochester, N. Y., has the electric light franchise for this city.

HUTCHINSON.—The construction of an electric light plant has been recommended by the City Council.

OSBORNE.—A franchise has been granted to parties for the construction of an electric light plant here.

WINFIELD.—The citizens have voted to issue bonds for the purpose of constructing an electric light plant.

NORTON.—The advisability of constructing an electric light plant here is being considered by the Council.

CONCORDIA.—Messrs. O'Reilly & Dougherty, of this city, have been granted a ten-year franchise for furnishing the city with electric lights.

PITTSBURG.—The Pittsburg Gas Light & Coke Company is now known as the Pittsburg Gas & Electric Light Company. Mr. C. A. Patmor is superintendent of the plant.

IOLA.—The city has decided to extend the electric light service to the west side suburb. This will require the installation of additional equipment, which will necessitate enlarging the power house. Between $5000 and $6000 worth of new machinery has been ordered and bids have been asked for for the erection of an addition to the plant. Mr. I. E. Patterson is superintendent.

KENTUCKY.

PADUCAH.—Mr. Julius Fryout is now chief engineer of the municipal lighting plant.

PEMBROKE.—The Pembroke Water Power & Light Company has been incorporated with a capital of $10,000 to supply the town of Pembroke with electric lights and water.

OWENSBORO.—It is understood that the Council is perfecting plans for the immediate enlargement of the city lighting plant.

COVINGTON.—The City Council of Covington contemplates building and installing an electric light and power plant at a cost of $75,000. The plant is to be capable of supplying 350 arc lights and 150 32-c.p. incandescent lights.

OAKDALE.—The American Electric Lighting Company, which purchased the franchise to light the recently incorporated town of Oakdale, has filed a charter fixing its capital stock at $10,000. The incorporators are: Mr. Charles A. Hess, Miss Mary Rosenfield, Mr. Louis F. Ott and Mr. Thomas F. Condon. The franchise was granted for twenty-five years.

GEORGETOWN.—The following are the officers of the Georgetown Water, Gas, Electric & Power Company: President and manager, Mr. J. P. Jackson; vice-president, Mr. G. V. Payne; secretary and treasurer, Mr. J. R. Holzman; purchasing agent, Mr. J. A. Stanton; superintendent and chief electrician, Mr. S. F. Allen, and chief engineer, Mr. John Stone.

BARBOURSVILLE.—At a meeting of the stockholders of the Barboursville Electric Light Company, held recently, it was decided to be impracticable to continue the service in this city on the present basis. The company has made an offer to the town by which it agrees to put in a number of extra lights without increasing the cost, but to run the lights on a midnight instead of an all-night schedule. The town authorities are considering the proposition.

LOUISIANA.

VIDALIA.—Mr. L. A. Larson has been made superintendent of the new municipal lighting plant.

MACON.—The city has voted $12,000 for the purchase and improvement of the electric lighting plant here.

OPELOUSAS.—The City Electric Light Company expects to install a series alternating-current arc light system, which will necessitate the installation of more machinery.

OPELOUSAS.—Knox, George & Company, of New Orleans, have been selected by the City Council to make a full investigation of the operation of the water works and electric light plant, with a view to a general overhauling of the same and installing some new apparatus.

NEW ORLEANS.—The Interstate Electric Company, of this city, has been awarded the contract to wire and light the town of Woodville, Miss. Mr. Isaac G. Marks, manager of the contracting department of the company, states that the whole city will be wired and lighted and a power house built, making the task a large one.

MAINE.

BANGOR.—Mr. M. H. Rideough is superintendent of the city electric light plant.

CHERRYFIELD.—Mr. Frank C. Nash is now president of the Cherryfield Electric Light Company.

BELFAST.—The Belfast Gas & Electric Company will increase its capital stock from $100,000 to $115,000.

PITTSFIELD.—The Pittsfield Electric Light & Power Company is now owned by the Sebasticook Water Power Company, of which Mr. Allen Hackett is president.

CLINTON.—A charter has been granted to the Clinton Electric Light & Power Company, recently incorporated. Mr. F. L. Besse is president, and

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Mr. M. Morrison, secretary and treasurer of the company.

BANGOR.—The Underwriters' Light, Heat & Power Company has been organized with a capital stock of $3,000,000. Mr. E. T. Nealy, is president of the company and Mr. Charles E. Dole, secretary and treasurer.

SEARSPORT.—The Searsport Electric Light Company has been organized by Messrs. Harry L. Cram and A. J. Desmond, both of Portland, for the purpose of manufacturing gas and electricity in Searsport. The capital stock is fixed at $10,000.

KITTERY.—The Arcadia Lighting Company has been incorporated with a capital stock of $100,000. Mr. E. L. Chaney is president and Mr. J. E. Forsyth, treasurer. Mr. L. H. Harriman and Mr. A. E. Knowlton are also among the incorporators.

GREENVILLE.—Articles of incorporation have been filed by the Greenville Light & Power Company, fixing its capital stock at $10,000. Mr. Charles D. Shaw, of this city, is president of the company. Work has been commenced on the power house and will be pushed as rapidly as possibly.

SOUTH ORRINGTON.—An effort is being made to interest the people in lighting their homes and places of business throughout the town with electricity. Negotiations have been opened with Bangor parties with a view to obtaining sufficient current for the purpose, and it is expected that the Council at its next meeting will make an appropriation for lighting the streets and public buildings by the same means.

ROCKLAND.—The following are the officers of the Rockland, Thomaston & Camden Street Railway Company, which has the lighting contract for the city: President, Mr. G. E. Macomber, of Augusta; vice-president, Mr. S. M. Bird, this city; secretary, Mr. H. M. Heath, of Augusta; treasurer, Mr. A. D. Bird, Rockland; manager, Mr. T. Hawken, Rockland; chief engineer, Mr. C. E. Gregory, Glencoe; chief electrician, Mr. George Gay, also of Glencoe.

MARYLAND.

ABERDEEN.—The Council has decided to expend about $8000 for the purchase or establishment of an electric light plant.

ROCKVILLE.—It is understood that the Council has decided to employ an engineer to prepare estimates for rebuilding or repairing the electric light plant which was burned several years ago.

TOWSON.—The County Commissioners have awarded to the Baltimore County Water & Electric Company the contract for supplying electric arc lights at Canton, Highlandtown and elsewhere at $90 a year for a term of five years and incandescent lights at $22.50 per year.

CUMBERLAND.—The Potomac Light & Power Company has been incorporated with a capital of $50,000 by Messrs. G. T. Blackford, George M. Botchford, William McL. Somerville, and others. The company offers to furnish the city free light for the City Hall and water works, and is asking for franchises.

BELAIR.—The Glencoe Power, Manufacturing & Supply Company has been organized for the development of water power and transmission of electricity, with Mr. C. A. Andrew as president and Mr. James T. Jones, secretary and treasurer. The company is authorized under its charter to generate and supply electricity for all purposes, also to build and operate steam or electric railways within the limits of Harford County.

MASSACHUSETTS.

WILLIAMSTOWN.—Mr. C. A. Roebuck is superintendent of the Williamstown Gas Company, which has the city electric lighting contract.

MILLIS.—The Town Council of Millis is considering the question of a three years' contract with the Medfield Electric Light & Power Company to furnish lights for the streets of that town.

INDIAN ORCHARD.—The contract has just been let for an electric light system and power plant at this point. The system will include a thousand incandescent lights and the power station will have a capacity of 1000 horse-power.

HUDSON.—Mr. William G. Lawrence, superintendent of the municipal electric light, has resigned his position on account of ill health, it is said. Mr. Lawrence has been in charge of the local plant for several years. He will be succeeded by Mr. J. C. Norcross.

LYNN.—The Lynn Gas & Electric Light Company has perfected plans for the placing of all electric wires except those used for the arc lights in underground conduits. Eventually the overhead system, with its poles and supports, will be supplanted by the essentials of a modern electric lighting system.

LANESVILLE.—Mr. Thomas H. Roberts, superintendent of the electric power plant here, states that the new machinery recently installed was considerably damaged by lightning a short time ago. The old engine was used to furnish power until the damage could be repaired.

MERRIMAC.—Work on the municipal light and power plant which is being installed in this city is progressing and the indications are that the plant will be in working order by September. About 200 of the proposed 400 poles have been set. There will be 300 lights which will light six miles of streets. It is estimated that the entire plant when complete will cost $11,000.

SUNDERLAND.—The Sunderland Electric Light & Power Company has bought what is known as the Munsell place in North Sunderland. A power house will be erected at the falls and a 45-h.p. Thomson-Houston generator will be installed. It is estimated that the plant will cost between $1200 and $1500, and it is hoped to have it in operation in a month or six weeks.

BOSTON.—The Universal Electric Corporation has filed articles of incorporation with a capital stock of $100,000. The promoters of the enterprise are Mr. Hiram P. Harriman, Wellfleet, president; Mr. N. Ellsworth Reed, Belmont, treasurer; Mr. Lewis E. Reed, Belmont, clerk, who, together with Messrs. George M. Palmer, Cambridge, and Hans Liebreich, of this city, constitute the board of directors.

HOLYOKE.—The Harbor & Land Commissioners have approved the plans of the Holyoke Water Power Company for the erection of a power station and the excavation of a raceway on the Connecticut River in Holyoke. The raceway will be about 600 feet long and 75 feet wide. The work will be begun as soon as detailed plans of the proposed station and appurtenances can be prepared and filed with the Board.

BEDFORD.—Electricity has been substituted for the old system of oil lamps for lighting the streets, and the Lexington Gas & Electric Company, of Lexington, has been awarded the contract to furnish current for incandescent lamps for a term of five years. Three miles of streets have been wired, the lamps being placed about 200 feet apart. The lamps will be lighted from sunset until 1 A. M., under what is known at the "dark-hour" schedule.

MICHIGAN.

EATON RAPIDS.—The citizens recently voted to issue water and lighting bonds.

ST. LOUIS.—Mr. R. W. Reading is superintendent of the St. Louis lighting plant.

WAUSAU.—The Town Council is considering a proposition to install a municipal lighting plant.

CLARE.—Mr. A. J. Doherty is now president and manager of the Clare Electric Light Company.

ALPENA.—The City Council is arranging to issue electric light bonds to the amount of $100,000.

ADDISON.—A vote is to be taken on the question of bonding the town for an electric lighting plant.

HOMER.—The Cortright Milling Company has the city lighting contract. Mr. W. H. Cortwright is manager.

MONROE.—Mr. William R. Goelliner is chief engineer of the municipal lighting plant, and Mr. F. J. Hill is chief electrician.

TRAVERSE CITY.—Bids are wanted May 31 for lighting the streets of the city for a period of five years from May 1, 1905.

PONTIAC.—The Council has advertised for bids for lighting the streets of the city by 136 arc lamps of 2000 candle-power each.

STANTON.—Mr. H. Busch is now superintendent of the municipal light and water plant, and Mr. C. F. Busch is the chief engineer.

ITHACA.—The citizens have voted to bond the village to the amount of $13,000 for the building and equipment of an electric light plant.

ROGERS.—Plans and estimates have been prepared for establishing an electric plant in Rogers for municipal and commercial lighting.

PORT HURON.—The Port Huron Light & Power Company has been awarded a five-year contract for lighting the streets of the city.

FLINT.—A new 300-h.p. boiler is to be installed in the plant of the Flint Light & Power Company, and a smokestack is to be erected 150 feet high.

SAGINAW.—Mr. W. A. Markey, of this city, has been selected by the City Engineer to assist in the preparation of plans for a municipal electric light plant.

PLAINWELL.—The Brownell Electric Company is investigating gasoline outfits, with a view to installing such a unit this summer to carry part of the load.

KALAMAZOO.—The Kalamazoo Electric Company will soon begin the construction of a power plant at Ceresco on Kalamazoo River, at an estimated cost of $200,000.

BUCHANAN.—The new electric light system has been completed and the town is again enjoying a complete lighting service. The streets have been in darkness since the first of last September.

PLAINWELL.—Bids have been called for for furnishing material and the electricity necessary to supply arc and incandescent street lights and arc and incandescent commercial and residential lights.

BEAVERTON.—The Beaverton Illuminating Company is owned by Ross Brothers. Mr. Ronald Ross is manager of the company; Mr. John Fitzgerald is superintendent, and Mr. William Sevier is chief electrician.

DETROIT.—The McCleary Electric Company has been incorporated with a capital stock of $10,000. Of this amount $6500 is said to have been paid in by the transfer of the McCleary & Colquitt Company's stock and fixtures.

ST. IGNACE.—This city has been left entirely without lights and fire protection, due to the destruction by fire of the water works and electric light plant, which was valued at $20,000. The plant will be rebuilt at once.

DETROIT.—The Peninsular Electric Light Company is making extensions to its three-phase power circuits. The company also lights the villages of Highland Park and Hamtramck. Mr. G. W. Cato is general superintendent.

BAY CITY.—The construction of a new municipal electric lighting plant, which has been under discussion for some time, is practically assured now. It is expected that a site on the river front will be selected for the new plant in order to obtain more power and secure better coal facilities.

BELLAIRE.—Reports state that Mr. Henry Richards, owner of the local power plant, is entertaining a proposition for the building of a 1000-h.p. plant here, to furnish a 24-hour alternating-current service and supply Charlevoix and other surrounding towns with current for lighting purposes.

GRAND LEDGE.—The Grand Ledge Electric Power Company has been incorporated by Mr. E. C. Jarvis, of Lansing, Mich., to acquire water power rights and build an electric plant for the purpose of supplying power to Grand Ledge and vicinity. The company's capital is fixed at $50,000. Messrs. Joseph H. Bootes and G. D. Smith, of Jackson, are also stockholders.

ALLEGAN.—The Allegan Light & Power Company, composed of Horace M. Olney, of Hartford, Mich., and A. B. Wilder, of Allegan, has sold its plant to Siebe Baker, Hiram A. DeLano and George E. DeLano, of Otsego, and Fenner M. Van Auken, of this city, who will continue the business under the same name. Current for domestic and commercial lighting and power purposes will be supplied as heretofore. The two plants here may be consolidated under the new management.

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MINNESOTA.

LANESBORO.—Mr. E. E. Lynch is superintendent of the Lanesboro Electric Company's plant.

FOSSTON.—Mr. John E. Domaas is superintendent and chief engineer of the village electric light plant.

THIEF RIVER FALLS.—It is understood that arrangements are being made to enlarge the city lighting plant.

LITCHFIELD.—Mr. E. Aveldson is manager and chief electrician of the municipal lighting plant of Litchfield.

STILLWATER.—The Stillwater Gas & Electric Company is contemplating the erection of a new power station.

ATWATER.—Village Recorder Larson writes that the citizens have voted to construct a water works system and an electric light plant.

RUSHFORD.—The City Council has advertised for bids for an engine, generator and material for an addition to the electric light plant here.

LITTLE FALLS.—The question of issuing $10,000 in bonds for building and equipping a lighting plant is under consideration by the Council.

SPRING VALLEY.—Mr. N. T. Cummings is now vice-president of the Spring Valley Electric Light & Investment Company, and Mr. G. M. Warren is treasurer.

ROYALTON.—The matter of establishing a municipal lighting system is to be submitted to a vote of the people. Plans and estimates of the probable cost of a plant are being prepared.

GRACEVILLE.—As the plant here is very much overloaded, the council is considering a proposition to increase the equipment by the addition of a 50-kw. unit. Mr. P. F. Daly is chief engineer and electrician.

DULUTH.—It is reported that arrangements have been made for the development of the water power of the St. Louis River. The contracts for equipment have not yet been made. Mr. C. A. Duncan, president, and Mr. C. C. Cokefair, general manager, of the Great Northern Power Company, are said to be interested in this enterprise.

MISSISSIPPI.

NEW ALBANY.—The City Clerk writes that an election is about to be held in connection with the matter of constructing an electric light plant.

MACON.—It has been voted by the citizens to purchase and refit the plant of the Macon Light & Power Company, and $20,000 in bonds have been issued for this purpose.

DELTA.—The Delta Electric Light & Power Company announces that it will immediately begin the work of extending its electric lines to take in all parts of the city.

OCEAN SPRINGS.—The work of installing an electric light system here has begun and will be pushed as rapidly as possible. There are to be arc lights at the street crossings. The company, it is said, has agreed to furnish lights for the churches and the town hall gratis if the necessary wiring is done by the parties interested.

LAUREL.—The officers of the Laurel Improvement Company, which has the contract for lighting the city, are as follows: President, Mr. S. M. Jones; vice-president, Mr. Edmund K. Stello, of New York City; secretary and treasurer, Mr. F. C. Harrington; superintendent, Mr. C. L. Williams; chief engineer, Mr. Benjamin Lee.

BOONEVILLE.—A franchise has been granted to local parties who have organized a stock company under the style of the Citizens' Light & Telephone Company, with a capital of $40,000, for the purpose of constructing a light plant and telephone system. Booneville has been without lights for some time and the new plant will be put in operation as soon as possible.

MISSOURI.

INDEPENDENCE.—Mr. J. T. Byars is superintendent of the city light plant.

BRUNSWICK.—Mr. William Steel is superintendent and chief electrician of the Brunswick water and light works.

ST. LOUIS.—The Suburban Electric Light & Power Company, of Webster Grove, St. Louis County, has filed a petition for a franchise to extend its lines over the county.

ST. JOSEPH.—An ordinance has been passed which provides for the issuance and sale of improvement bonds to the amount of $75,000 for purchasing a site and building thereon an electric light plant.

MEXICO.—Mr. W. F. Atkinson is now vice-president of the Mexico Electric Light, Heat & Power Company, succeeding Mr. J. W. Wooldridge. Mr. J. M. Howe is manager and chief electrician, and Mr. Morgan Day is chief engineer.

LEBANON.—We are advised of the incorporation of the Lebanon Electric & Power Company, with a capital of $2000, which proposes to construct and operate an electric light plant in Lebanon. Messrs. W. P. Simpson and W. I. Diffenderfer, of this city, are among the stockholders.

JOPLIN.—Work on the large power plant being erected by the Spring River Power Company at Lowell, Kan., is being pushed so rapidly that it is now thought the company will be in position by September 30 to furnish some power, although as previously reported, it will probably be a year before the plant is entirely completed.

MONTANA.

TOWNSEND.—The electric light plant of this place is now owned and operated by Bowhay Brothers.

LIBBY.—Mr. A. B. Johnson, of this city, has been granted a franchise for the establishment of an electric light plant and a telephone system.

RED LODGE.—The electric light plant of this place is now owned by the Northwestern Improvement Company. Mr. Robert Pettigrew is superintendent of the plant.

MISSOULA.—The Missoula Light & Power Company and the Missoula Water Company, of this city, have consolidated under the title of the Missoula Light & Water Company.

GREAT FALLS.—The present officers of the Boston & Great Falls Electric Light & Power Company are: President, Mr. John D. Ryan, of Butte, Mont.; secretary, Mr. J. C. Lalor, also of Butte; superintendent, Mr. E. I. Holland.

LEWISTOWN.—The Lewistown Electric Light & Power Company recently sold out to Bach & Cook, who have consolidated with the Citizens' Electric Light & Power Company. The plant has been greatly enlarged. The new company's capital is $50,000, and Mr. John Bright is president and manager.

NEBRASKA.

FALLS CITY.—Mr. A. Neitzel is at present superintendent of the municipal light plant.

SHELTON.—A new power house is soon to be erected by the Shelton Water Power Company.

OMAHA.—The citizens of this city are discussing the proposition of voting bonds for the construction of a municipal lighting plant.

STANTON.—The plant of the Stanton Electric Light Company is now owned by Mr. F. L. Sanders, formerly manager of the old company.

OAKLAND.—The proposition to issue $7000 in bonds for the construction of an electric light plant was carried at a recent election held for the purpose.

CRETE.—A new boiler is to be added to the equipment of the municipal electric light plant, of which Mr. Camel, of this city, is superintendent and chief electrician.

CHADRON.—The officers of the Chadron Electric Light & Power Company are as follows: President, Mr. H. H. Woodman; secretary, Mr. W. C. Walther; treasurer and manager, Mr. A. H. Savage; superintendent, Mr. R. B. McFadon; all of St. Paul, Minn.; and chief engineer, Mr. C. W. Reid, of this city.

NEVADA.

RENO.—The Washoe Power & Development Company has decided to place orders for all necessary equipment and machinery for its power plant, in order that the plant may be ready for operation in six months. Definite action is delayed pending the receipt of a report from the company's engineer.

RENO.—The Reno Power, Light & Water Company is engaged in the construction of two large reservoirs, the larger of which will have a storage capacity of 60,000,000 gallons and the smaller a capacity of about half that amount. The expense already incurred in construction work approximates $50,000, and the company plans the construction at some future period of another reservoir of still greater capacity. Bonds to the amount of $750,000 are to be issued by the company for the improvement and enlargement of the system.

NEW HAMPSHIRE.

WARREN.—An electric light plant is soon to be established here.

CLAREMONT.—The Claremont Railway & Lighting Company is arranging to increase its power equipment by the installation of an engine and boiler.

KEENE.—The following are the officers of the Keene Gas & Electric Company, which has a paid-in capital stock of $150,000: President, Mr. W. H. Elliott; vice-president, Mr. W. L. Mason; secretary and treasurer, Mr. G. M. Rossman, who is also manager and superintendent; chief electrician, Mr. W. A. Whitman. The company has the contract for lighting the city, supplying current for 55 arc lights of 1200 candle-power and 121 32-c.p. incandescent lights.

NEW JERSEY.

BOGOTA.—The Bogota Water & Light Company has filed a certificate increasing its capital stock from $10,000 to $20,000.

HACKENSACK.—Mr. E. C. Deal is now superintendent of the Hackensack plant of the Gas & Electric Company of Bergen County.

PATERSON.—The Public Service Corporation has secured the contract for lighting the streets at $101 per arc lamp and $18 per gas lamp.

WILDWOOD.—Mr. Frederick Sutton is now manager of the electric plant here, which is controlled by the West Jersey Electric Company.

SEA ISLE.—The stockholders of the Sea Isle City Electric Light, Heat & Power Company have disposed of their plant to the New Jersey Rapid Transit Company.

WEST HOBOKEN.—The contract for lighting the streets for a term of five years at $100 per arc lamp per year has been awarded to the Public Service Corporation.

WEEHAWKEN.—The Weehawken Construction Company has secured the contract for lighting the township with electricity for a term of thirty years at $90 a lamp per year.

PRINCETON.—The Princeton Lighting Company, which began operations last year, is a consolidation of the Princeton Electric Works, Princeton Gas Light Company and the Hopeville Electric Heat & Power Company. The Princeton Company also controls the Jamesburg Electric Light, Heat & Power Company and the Freehold Electric Light, Heat & Power Company. Mr. Charles P. Fitch is president and manager, and Mr. Robert Tynck is superintendent. The company has the city lighting contracts for seventeen towns. Extensive improvements are being made, which are still in course of construction.

TRENTON.—In increasing its capital stock from $10,000 to $4,000,000, the amended articles of incorporation of the National Gas, Electric Light & Power Company state that the company's object is to buy, acquire, lease, construct, develop, improve, maintain, operate and deal in and with properties, rights and franchises for or connected with the production and distribution of light, heat and power by means of gas, electricity or other agent. Mr. James T. Lyon is president and Mr. Frank K. Pelton, secretary. Among the other stockholders are Mr. Robert T. Gray, Mr. Theo. H. Eaton, Mr. E. L. Kelsey, Dr. J. B. Book, Mr. A. L. Stephens, Mr. F. M. Osborne, Mr. Charles W. Miller, Mr. E. T. Lynch, Mr. M. B. Dady, Mr. John D. McMahon, Mr. Ellwood T. Hance, Mr. A. D. Bennett and Mr. J. C. Duffield.

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NEW MEXICO.

CARLSBAD.—Messrs. William A. Finley and Matthew S. Grover are among the directors of the Public Utilities Company, which is making arrangements to construct an electric light plant and water works here.

TUCUMCARI.—The Tucumcari Water, Ice & Power Company, with an authorized capital stock of $25,000, recently commenced operations here, having acquired the plant and property of the Tucumcari Electric Light & Water Company. Mr. Alexander D. Goldenburg is president; Mr. L. E. Taylor, vice-president and engineer; Mr. A. S. Donoghue, secretary, treasurer and manager; Mr. J. H Laurie, Almagordo, superintendent. The company is contemplating the construction of water works and an ice plant in the immediate future.

NEW YORK.

BOONEVILLE.—Mr. George O. Bridgeman is superintendent of the village electric light plant.

GLENS FALLS.—Mr. E. A. Wakeman is superintendent of the Glens Falls Gas & Electric Light Company.

WATKINS.—Bids have been called for by the Board of Water and Sewer Commissioners for $20,000 electric light bonds.

FISHKILL-ON-HUDSON.—Mr. J. Donnelly is superintendent of lighting for the Citizens' Railway, Light & Power Company.

BALDWINSVILLE.—The plant of the Edison Illuminating Company, of this place, has been sold to the Seneca River Power Company.

LOCKPORT.—The shareholders of the Niagara, Lockport & Ontario Power Company have voted to increase the capital of the company from $1,000,000 to $10,000,000.

NEW YORK CITY.—The Twombley Power Company has been incorporated with a capital stock of $45,000. Among the directors are Messrs. W. I. Twombley and C. C. Dodge.

FULTON.—Mr. C. W. Tippy has resigned his position as manager of the Fulton Fuel & Light Company to accept one as superintendent of manufactures of the Rochester Gas & Electric Light Company.

ATTICA.—The plant of the Attica Electric Light Company was badly damaged by lightning a short time ago. All but two transformers on one circuit were blown out and all the arc lights were put out of service. The damage was repaired as speedily as possible.

POTSDAM.—Mr. J. Alguire, for some time chief electrician of the Potsdam Electric Light & Power Company, has been appointed manager of the company to succeed Mr. Heatley Green who recently resigned. Mr. Green has also resigned as director of the company and disposed of his stock.

CHATHAM.—The following are the officers of the Chatham Electric Light, Heat & Power Company: President, Mr. E. R. Coffin, Schenectady; secretary and treasurer, Mr. H. M. Francis, Schenectady; manager and chief electrician, Mr. J. F. Wilson; chief engineer, Mr. William C. Reed.

HEMPSTEAD, L. I.—A franchise for fifty years has been granted to the Queens Borough Gas & Electric Company, of Far Rockaway, conveying the privilege to string wires, erect poles and lay pipes along the county roads in the town of Hempstead for the supply of gas and electricity for lighting and heating purposes.

MIDDLEVILLE.—The Middleville Electric Light Company has been incorporated with a capital of $4000. The company will construct a plant for the generation of electricity to be used for light, heat and power purposes in Middleville, Fairfield and Herkimer. Messrs. Lewis H. Goodman and David E. Ford and Anna M. Goodman are among the directors.

NORTH ELBA.—Articles of incorporation have been filed by the Ausable Valley Light, Heat & Power Company, fixing the capital stock at $30,000. The directors named are Messrs. Wallace Murray, F. A. Gould, A. K. Botsford and C. F. Carpenter, of Saranac Lake, and Ernest Parker, of Keene. The company will operate in Keene, Jay, North Elba and Wilmington, Essex County.

PLATTSBURG.—Bids have been advertised for lighting the streets of the town for a period of five years from November 6 next, requiring 80 arc lights of 2000 candle-power each, or 60 arc lights of 2000 candle-power and 25 32-candle-power incandescent lights or their equivalent. The bids are to be submitted on a schedule until 1 A. M. and on a schedule from one-half hour after sunset until one-half hour before sunrise.

WESTCHESTER.—The employes of the local branch of the Westchester Lighting Company recently organized at the local offices of the company a branch of the Employes' Benevolent Association of the Westchester Lighting Company. Twenty-two charter members went into the organization, and the following officers were elected: President, Mr. James Boyan; vice-president, Mr. Albert Peffers; secretary and treasurer, Mr. Thaddeus Le Veniss. Delegations from the Mount Vernon and Yonkers branches were also present.

NEWBURG.—At the annual meeting of the Upper Hudson Electric Company, held in this city recently, the following officers were elected: President, Mr. L. F. Gillespie, of this city; vice-president, Mr. Eugene Wolf, of Athens; secretary, Mr. J. M. Sheehan, of this city; treasurer, Miss A. B. Hedges, Newburg. The company has electric light and power plants at Athens and Coxsackie, and not only furnishes power for those two villages, but also for New Baltimore, Coeymans and Ravena. Its territory extends from a point near the north line of the town of Catskill almost to Albany.

NIAGARA FALLS.—At a meeting of the directors of the Niagara Falls Power Company, June 23, the following officers were elected: President, D. O. Mills, New York; first vice-president, Edward A. Wickes, New York; second vice-president and treasurer, William B. Rankine, Niagara Falls; third vice-president, George W. Davenport, Niagara Falls; secretary, Frederick L. Lovelace, Niagara Falls; assistant secretary and treasurer, W. Paxton Little, Niagara Falls; executive committee, D. O. Mills, John Jacob Astor, Francis Lynde Stetson, Edward D. Adams, Charles Lanier, F. W. Whitridge, all of New York, and Victor Morawetz, of Philadelphia.

SPIER FALLS.—The Hudson River Water Power Company operates by means of power obtained from the Hudson River. Its equipment includes four 2000-kw. and two 2500-kw. alternating-current generators. The company furnishes 24-hour power service for the General Electric Company at Schenectady and the Hudson Valley Railway Company at Glens Falls and Saratoga. The current is transmitted over four circuits at 30,000 volts. Current for lighting purposes is supplied to Glens Falls, Saratoga, Ballston, Schenectady, Troy and Albany. Distribution is effected by means of six sub-stations located respectively at Glens Falls, Saratoga, Ballston, Alplaus, Watervliet and Albany.

WESTCHESTER.—An announcement of the purchase of the Westchester Lighting Company, which controls the electric lighting and gas lighting of a large portion of Westchester County, by the Consolidated Gas Company, is made, as it is understood that negotiations have been practically completed. The Westchester Company is capitalized at $12,500,000, $2,500,000 of this being 6 per cent. preferred stock. It has $3,999,000 of first mortgage 5 per cent. bonds. The Westchester Company was organized by the United Gas Improvement Company, of Philadelphia, and among the cities which it serves are Yonkers, New Rochelle, Mount Vernon, Pelham and White Plains. It owns valuable franchises, and its business has steadily increased with the development of Westchester County.

ADDISON.—Mr. F. H. Wheaton has disposed of his entire electric plant, including the poles and wires, together with his contract for lighting the streets of the village. Mr. J. F. Hubbs, of Hammondsport, who owns and controls several power plants throughout the State, is the purchaser. A new power house will be built to take the place of the one recently destroyed by fire. It will be a substantial brick structure and equipped with a double set of machinery capable of meeting all demands for lighting the streets, residences and business places of the village. Mr. Hubbs will submit a proposition to the Village Trustees to light the streets every night on an all-night schedule at an additional cost of $5 per light on the present yearly contract. It is expected that the plant will be ready for operation in about two months.

ROCHESTER.—A certification of consolidation of the Rochester Gas & Electric Company and the Rochester Light & Power Company, under the title of the Rochester Railway & Light Company, has been filed at Albany with the Secretary of State. The capital is $11,000,000, divided into 45,000 shares of preferred and 65,000 shares of common stock. The preferred stock is to bear 4 per cent. dividends for two years, and 5 per cent. thereafter. The directors are Frederick Cook, Alexander M. Lindsay, Edward Bausch, Albert O. Finn, G. A. Hollister, Thomas W. Finncone, George W. Archer, Henry A. Strong, Eugene H. Satterlie and Albert H. Harris, of Rochester; Henry D. Walbridge and Anton G. Hodenpyl, of New York City; Edward W. Clark, Jr., and Clarence M. Clark, of Philadelphia, and James Richardson, of Providence, R. I.

AMSTERDAM.—Representatives of the Hudson Valley Power Company, of Spier Falls, recently visited the Schoharie Falls plant of the Empire State Power Company of this city. It is believed that this visit is a preliminary to the absorption of the Empire concern by the Hudson Valley Company. It is the purpose of the latter company, in the event of the purchase of the Schoharie plant, to develop the water power of the river to the full extent and to operate the plant as an auxiliary to its large establishment at Spier Falls. In addition to serving Amsterdam consumers with electrical power from the plant of the present Empire State Power Company, it is stated that the construction of a transmission line is contemplated from this city to Spier Falls, so that in the event of temporary suspension of one plant power could be obtained from the other.

MECHANICSVILLE.—Considerable discussion has been aroused here by the report that it was the intention of the Hudson River Power Company, which operates the power plant below this village and at Spier Falls, to apply for a franchise to set poles and string wires in Mechanicsville for the purpose of furnishing electric power. Neither of the electric light companies now doing business here run a day circuit for power purposes, but the Mechanicsville Electric Light & Gas Company contemplates raising its dam at Willow Glen with this end in view, and the Halfmoon Light, Heat & Power Company is said to be negotiating with other parties for day power for the same purpose. For this reason, together with the fact that there are two telegraph companies, two telephone companies, two electric light companies and a trolley company, each with a set of poles on the public streets, the proposition to erect another set does not meet with favor by the citizens.

NORTH CAROLINA.

LEXINGTON.—Bids have been called for for the $61,000 bonds which the Council recently decided to issue for the construction of an electric light plant and water works.

OXFORD.—Water works and an electric light plant are to be constructed in this city by Messrs. Edward G. Frost, of Salisbury, and F. W. Siebert. The cost of the proposed plant is estimated at $60,000. The town has voted to pay the company $3500 annually for light and water service.

ASHEVILLE.—The W. T. Weaver Power Company, utilizing the power of the French Broad River at Asheville, is now supplying power to the Biltmore estate of Mr. Vanderbilt. The company has been successful in securing contracts to furnish power to a number of former steam plants in the city.

NORTH DAKOTA.

GRAND FORKS.—It is the intention of the Grand Forks Gas & Electric Company to expend about $20,000 in improvements.

OHIO.

GLENVILLE.—The City Council has advertised for bids for lighting the streets with electric lights.

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PROSPECT.—Mr. George Whysall is manager and purchasing agent of the Electric Light Company, of this city.

NILES.—The Niles Electric Company has been incorporated with a capital stock of $10,000. Among the directors are Messrs. F. W. Stillwagon and W. H. Smiley.

YOUNGSTOWN.—The power plant of the Youngstown-Sharon Power & Light Company is said to have been damaged by fire to the extent of $25,000.

SANDUSKY.—An ordinance has been passed granting the right to Mr. C. B. Dewitt to construct, maintain and operate an electric light, heating and power plant.

ROCKY RIVER.—The Rocky River Water, Light & Power Company has been incorporated with a capital of $75,000. Messrs. R. Fisher and C. Burkhardt are among the directors.

WARREN.—The Warren Water & Light Company, with a capital of $250,000, is a consolidation of the Warren Electric Light & Power Company and the Warren Water Company.

MANSFIELD.—Messrs. H. M. Byllesby and A. S. Huey, both of Chicago, have been elected president and vice-president respectively of the Mansfield Railway, Light & Power Company.

COLDWATER.—A franchise has been granted to Mr. R. C. Stueve, of Wapakoneta, to construct and maintain an electric light plant here. The franchise is for ten years and stipulates that operations shall begin not later than December 1 of this year.

SANDUSKY.—The following-named gentlemen have been elected officers of the Sandusky Gas & Electric Company: President, Mr. B. Mahler; vice-president, Mr. O. B. Wilcox; secretary, Mr. F. W. Coen; treasurer, Mr. A. L. Moss; general superintendent, Mr. A. C. Blinn.

McCOMB.—The McComb electric light plant, including all machinery and apparatus, poles and wiring for lighting the city, has been sold to Mr. William H. Frederick, of Bowling Green. Mr. Frederick virtually owned the plant and only bid it in in order to perfect his title. He is said to be negotiating for its sale with Mr. H. Mitchell, of Findlay, who was the only competitive bidder.

CINCINNATI.—The following contracts have been closed by President Norman G. Kenan, of the Cincinnati Gas & Electric Company, with the Westinghouse Company for a 1000-kw. motor-generator set, with the General Electric Company for 50,000 feet of covered cable feeders for use in underground conduits, and with the Standard Underground Cable Company for 100,000 feet of overhead wire.

MARION.—The officers of the Marion Electric Light & Power Company, which is a consolidation of the Marion Electric Light Company and the Marion Street Railway Company, are as follows: President, Mr. J. G. Webb, Springfield; vice-president, Mr. George S. Bright, Columbus; secretary, Mr. J. L. Vance, Jr., Columbus; treasurer, Mr. W. Guy Jones, Columbus; general manager, Mr. George Whysall; superintendent, Mr. R. E. Amman.

YOUNGSTOWN.—Mr. Albert Pabst, who was for eighteen years with the Youngstown Consolidated Gas & Electric Light Company as superintendent of the power house, recently resigned his position and will take a much needed rest, leaving shortly for a trip abroad. Mr. Pabst is succeeded by Mr. H. L. Patterson, who has been in the employ of the company for some time. Mr. Patterson, previous to his connection with this company, was with Sanderson & Porter, electrical construction engineers of New York City.

CINCINNATI.—A number of local interests are forming a company to undertake the work of utilizing for power and commercial purposes the Ohio River from Pittsburg to Cairo. The object is to construct a system of reservoirs at the headwaters of all the rivers and streams emptying into the Ohio along its entire length, thereby controlling the waters of the Ohio River. Another meeting of the projectors is to be held soon to decide whether the Government shall be requested to conduct the enterprise or whether it shall be carried out by private capital.

OKLAHOMA TERRITORY.

ALVA.—The Alva Light & Power Company is officered as follows: Mr. N. R. Gascho is president, manager and superintendent; Mr. R. P. Erwin is vice-president, secretary and treasurer, and Mr. L. D. Gascho is chief engineer and electrician.

OREGON.

ALBANY.—A franchise for the construction of an electric plant and telephone system in this city has been granted to Mr. W. D. DeVarney.

PORTLAND.—The Citizens' Light & Traction Company has been incorporated, with a capital of $200,000, by Messrs. A. Welch, O. Lowengart, Fred Langeman, Louis Sommer and M. Hoff.

SILVERTON.—A press report states that it is the intention of the Union Light & Power Company to expend about $50,000 in improvements at its water-power plant. Mr. A. B. Kurtz is superintendent.

MARSHFIELD.—Mr. F. M. Friedberg has sold his electric light plant to Mr. C. F. MacKenzie, of Colfax, Wash. The new proprietor intends to double the capacity of the plant and make other improvements.

GOLD HILL.—The Gold Hill Development Company, represented by Mr. H. Schaeffer, recently bought of J. J. Houck water power privileges for mining and manufacturing purposes, etc. It is the purpose of the company to furnish electric power for all purposes. It is expected that 8000 horse-power can be developed, for which purpose it will be necessary to construct a canal 2100 feet long, 50 feet wide and 8 feet deep with a 26-ft. constant head.

LA GRANDE.—The large Morgan Lake water power system, situated three miles south of this city on the summit of the Blue Mountains, which has been in course of construction by the La Grande Water Storage Company, is practically completed, and the storage company will soon be prepared to furnish the city with 75,000,000 gallons of water per month for distribution through the city water mains. In addition to this water will be supplied to a power plant, located one mile down the canyon from the lake, by means of steel pipe two feet in diameter. One thousand horse-power will be developed at first, the plant to have an ultimate capacity of 10,000 horse-power. The elevation of the lake above the city is 1450 feet in three miles. A lake 120 acres in extent and now averaging 12 feet in depth has been formed, with a possibility of increasing the depth to 30 feet by building a few hundred feet of levee.

PENNSYLVANIA.

NEW HOLLAND.—An electric light system is being installed here.

BROOKVILLE.—The construction of a new electric light plant is being discussed here.

LEWISTON.—The Lewiston Electric Light, Heat & Power Company is having plans drawn for a new power plant.

SHICKSHINNY.—Mr. J. Warren Briggs is superintendent and chief electrician of the municipal lighting plant of this city.

PHILADELPHIA.—The Frank M. Stewart Electric Company has filed articles of incorporation, placing its capital stock at $100,000.

CHAMBERSBURG.—Mr. S. M. Wheeler has been re-elected superintendent of the Chambersburg electric light plant.

WILLIAMSPORT.—New machinery is being installed in the plant of the Lycoming Electric Company, which will greatly increase its capacity.

COATESVILLE.—The incorporation of the Coatesville Consumers' Electric Light, Heat & Power Company, with a capital of $15,000, is reported.

ALLEGHENY.—The plant and stock of the Allegheny Light & Power Company have been damaged by fire to the extent of $35,000, according to recent reports.

NEW CASTLE.—Reports are to the effect that the Council will expend $8000 more on the extension of the municipal conduit system, which already has cost $60,000.

CRESSON.—Mr. W. A. Thomas is superintendent of the Cresson Electric Light Company, instead of Mr. D. P. Conrad, as stated in these columns last month.

READING.—A bill calling for a special election to obtain the assent of voters for a $200,000 loan for a municipal electric light plant was defeated in the Select Council.

DANVILLE.—The contract for the construction of the municipal electric light plant has been awarded to the Rumsey Electric Manufacturing Company, of Philadelphia, at $15,000.

PHILADELPHIA.—Recent reports are to the effect that Mr. J. H. Mack and associates are organizing a new electric light company capitalized at $8,000,000 to compete with the Philadelphia Electric Company.

FRANKLIN.—Messrs. O. C. Harris and D. W. Klinefetter, with others, are applying for a charter for the Franklin Electric Company, the purpose of the company being to supply light, heat and power in the borough.

WILLIAMSPORT.—Bids have been called for by the Light and Water Committee of the City Council for lighting the streets, city hall and several engine houses with either gas or electricity for a term of five or ten years.

MYERSTOWN.—Reports state that a representative of Lovegrove & Company, of Philadelphia, has been in this city recently with a view to organizing an electric light company. He solicited for half the stock, the remainder to be controlled by Lovegrove & Company.

NEWPORT.—Negotiations for the consolidation of the rival electric light companies of this city have been consummated and an agreement reached by which the Juniata Electric Company, in consideration of $26,000, purchases the plant and franchise of the Perry Electric Light, Heat & Power Company.

YORK.—The plan to establish a municipal lighting plant is being discussed by the Council. It is proposed to convert the crematory plant into a power house, instead of a municipal hospital, as has been suggested, and it is believed that favorable action in the matter will be taken shortly.

SLATINGTON.—At the annual meeting of the stockholders of the Citizens' Electric Light, Heating & Power Company, the following-named gentlemen were elected as directors for the ensuing year: Messrs. Fred Horlacher, E. D. Peters and Charles Benner, Jr., of this city, and Hons. Robert E. Wright and Hugh E. Crilly, of Allentown.

STROUDSBURG.—The erection of a plant at the Water Gap by the Delaware Water Gap Water & Power Company is being fought by local parties interested in a similar enterprise, who claim that the taking of water from the creeks would interfere with their rights. The company's plan is to combine the waters of Brodhead and Cherry Creeks, and it expects to erect a power plant at the Gap, where there would be a head of 100 feet of water, and furnish 5000 horse-power daily.

YORK HAVEN.—The York Haven Water & Power Company has issued $1,000,000 in bonds, which will be used for new equipment and extensions as they become necessary, the acquiring of additional property and such other needs as the growth of the company may require. The company is already engaged in the work of rebuilding that portion of its plant which was destroyed by the high water and ice several months ago. Work on the construction of the dam that is to furnish the water supply from the Susquehanna River has been resumed, and instead of erecting a temporary wall in the generating room for protection from the river, the company has had a strong brick river defence constructed.

SOUTH CAROLINA.

FORT MILL.—Mr. W. B. Moore, of Yorkville, is preparing plans for an electric light plant and system of water works to be constructed in this city.

LANCASTER.—The question of voting bonds for a municipal lighting plant is being discussed by the city. There is also talk of securing the power from a local cotton mill.

BATESBURG.—Bids are wanted for the $20,000 bonds recently voted for by the citizens, the

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amount to be used for the purpose of installing an electric light plant and water works.

BELTON.—A charter has been applied for by Messrs. J. B. Adger, of Charleston, E. A. Smith, of Pelzer, and R. A. Lewis and J. T. Rice, of this city, with others, for the Belton Water Power Company.

CHARLESTON.—At the recent annual meeting of the Charleston Light & Water Company directors were elected for the ensuing year, with Mr. A. H. Post, president, and Mr. Zimmerman Davis, secretary and treasurer.

CHARLESTON.—Interests identified with the Charleston Consolidated Railway, Gas & Electric Company have chartered the Carolina Development & Construction Company, of Charleston, S. C., for the purpose of developing water powers in this State and the transmission of energy to manufactories. The company has organized as follows: P. J. Balaguer, of Charleston, S. C., president; E. W. Wynne, of Charleston, S. C., vice-president; F. K. Myers, of Charleston, S. C., secretary and treasurer; W. W. Fuller, engineer; M. Rutledge Rivers, of Charleston, S. C., general counsel; P. J. Balaguer, E. W. Wynne, B. A. Hapgood, W. G. Green, J. H. Dingle, J. Lamb Perry, C. F. Middleton, G. M. Politzer, F. K. Myers, directors.

SOUTH DAKOTA.

WILMOT.—The Town Council is considering a proposition to construct an electric light plant.

GROTON.—The Groton Light, Heat & Power Company has been organized with Mr. H. C. Miles as president and Mr. J. D. Jones, secretary. The company will erect its plant at once.

TENNESSEE.

CLARKSVILLE.—The Queen City Electric Light & Power Company proposes to install a new 150-kw., 1150-volt, 60-cycle monocycle generator and engine.

SPRINGFIELD.—The services of Mr. Granberry Jackson, of Nashville, have been secured by the town to prepare plans for the new water and lighting system. Bids will soon be called for.

DECHERD.—The Cumberland Oil, Light & Water Company has secured a franchise to furnish Decherd with light and water. Work on the necessary equipment will begin at once.

KNOXVILLE.—The Lighting Commission has presented a report to the City Council, in which it is recommended that the city build and operate its own electric light plant; also that a lighting committee be appointed by the Mayor with power to employ an expert electrical engineer to prepare plans and specifications for such a plant. It is estimated that the plant will cost about $137,000.

CHATTANOOGA.—Mayor Chambliss of Chattanooga has been making some interesting comparisons of the cost of lighting in cities which buy their light from private companies and those which own and operate their own plants. He recently called attention to the contrast afforded by the low cost per arc at which Nashville, which operates its own plant, is lighted as compared with the much higher price paid by this city. Chattanooga pays $85 per arc lamp, while the same service costs Nashville a trifle less than $50. Mayor Head, of Nashville, states that the total cost for lighting the city under contract had been about $49,000 per annum for 382 arc lights. On October 1, 1902, the city's new electric plant was completed at a total cost of $153,980.66, and the actual cost of operating the plant for twelve months was $35,162.96, which included interest on bonds, betterments, etc. The plant furnished 630 arc lights and 1961 incandescent lamps, as against the 382 previously furnished. After it had been decided to construct this plant, the private company voluntarily reduced its price to consumers from 18 to 12 cents per kilowatt, and contracts are now being made with the company for a term of years at 5 cents per kilowatt. The actual cost to the city, using its own plant, for producing electricity during twelve months was 2.65 cents per kilowatt.

TEXAS.

EL PASO.—The International Light & Power Company is installing a 500-kw. turbine in its power plant.

McKINNEY.—An $8000 bond issue has been voted for by the citizens to provide for the construction of an electric light plant.

ALVARADO.—The Alvarado Water, Light & Power Company has been incorporated with a capital of $40,000, by Mr. J. P. Parr, Mr. R. A. Messick, and others.

EL PASO.—The Suburb Gas, Light, Heat & Power Company was recently organized. The articles of incorporation fix the capital at $10,000 and Messrs. P. F. and P. J. Edwards are named among the directors.

TERRELL.—The Terrell Electric Light Company is extending its circuits to include some large plants which propose to utilize the current for power purposes. The company also controls the Kaufman Electric Light Company, of Kaufman, this state.

DENISON.—Mr. John R. Cullinane has resigned his position as secretary of the Denison Light & Power Company to assume the management of the Texarkana Lighting & Power Company. Mr. Cullinane had been connected with the Denison plant since 1886.

DALLAS.—The Dallas Electric Light & Power Company has perfected plans for the immediate erection in this city of a new power plant to cost when completed about $500,000. The constsuction work is already under way and it is expected that the entire plant will be ready for use within a year's time. A complete equipment of new machinery will be installed, the old steam engines now in use to be replaced by steam turbines. Mr. M. M. Phinney is general manager.

AUSTIN.—A proposition for the rebuilding of the dam across the Colorado River at Austin has been submitted by Mr. R. C. Deeming, of the Deeming Investment Company, Kansas City, Mo., and Dr. John M. Jacobs, of Lansdale, Pa., and is now under consideration by the city authorities. Messrs. Deeming and Jacobs offered to assume the bonded indebtedness of the city, amounting to $1,400,000, and to invest $500,000 in rebuilding the dam, water works and electric light plant, in return for a fifty-year water and light franchise from the city.

UTAH.

SALT LAKE CITY.—An Eastern syndicate, represented here by Mr. M. H. Boutelle and associates, has in view the purchase of the plant of the Salt Lake Water & Electrical Power Company, and with that end in view a postponement of the foreclosure suit against the company has been secured. The property is of considerable value, and if the purchase is consummated, an additional plant will be installed by the syndicate.

LEHI.—The directors of the Utah County Light & Power Company, consisting of Messrs. A. J. Evans, John C. Cutler, Sven L. Swenson, William H. Merritt, C. B. Harper, James H. Clark, S. L. Chipman and John Wotton, recently visited the company's plant at the mouth of American Fork canyon, for the purpose of inspecting the improvements just completed at a cost of $20,000. A location for another plant was also made and the president, Mr. Evans, was instructed to change the recent location decided on, so as to take the water from the creek at a point near Hanging Rock, about four miles up the canyon, whence it will be conveyed a short distance above the intake for the present plant. It is proposed to put in a flume 200 feet long, 6x6 feet, and then continue with a 3-ft. wooden pipe to the new plant, where two 1000-h.p. Pelton wheels will be installed. In the two miles of new pipe line there will be a fall of 569 feet, while in the old line, which is 1⅝ miles long, there is only a fall of 292 feet, and but 800 to 900 horse-power is generated at the old plant.

VERMONT.

MONTPELIER.—Mr. Edward P. Coleman is now vice-president and manager of the Consolidated Lighting Company.

BRANDON.—At the annual meeting of the Neshobe Electric Light Company, held here recently, the directors elected officers as follows: President, Dr. O. C. Baker; vice-president, Mr. Charles Dewey; treasurer, Mr. George H. McLeod.

ST. ALBANS.—The construction of the substation for the distribution of electricity to be transmitted from Fairfax Falls to this city by the Vermont Power & Manufacturing Company has been commenced upon the lot on South Main Street just beyond the city limits, recently purchased for the purpose. The work will be prosecuted rapidly and it is expected that the transformers and other machinery for the station will be set up and ready for operation very shortly.

VIRGINIA.

FRONT ROYAL.—Reports state that a bond issue of $15,000 has been voted for the purpose of constructing an electric light plant.

STUART.—The Electric Light & Power Company has been incorporated with a capital of $5000. It is the purpose of the company to have the plant in working order and the town lighted by September 1. Mr. John Axford is president, and Mr. E. J. Jarvey, secretary.

MARTINSVILLE.—The Town Council has purchased the water power at Hairston's Mill owned by Col. Peter Hairston. According to press reports, this purchase will insure either the partial or full development of the power at this point in the near future and the lighting of the town by electricity.

PETERSBURG.—A special meeting of the finance committee of the City Council was held recently for the purpose of considering the question of the city building and owning an electric light plant. The city pays annually to the Virginia Passenger & Power Company between $13,000 and $14,000 for electric lights for its streets and public buildings. There is a strong sentiment among the people and councilmen in favor of municipal ownership, and it is believed that favorable action in that direction may be taken in the early future.

WASHINGTON.

ELMA.—The City Council is considering the question as to whether it is advisable to grant a franchise for the construction of an electric light plant or to erect a municipal plant.

PALOUSE.—Mr. A Anderson is superintendent and chief engineer of the electric light plant owned by Mr. D. G. Klinefelter. Mr. George Emmett is chief electrician. Mr. Klinefelter has the city lighting contract for eleven years.

PROSSER.—Mr. E. F. Benson, of Tacoma, superintendent of the Prosser Falls Land & Irrigation Company, together with United States Senator Ankeny, will soon begin improving the water power at Prosser Falls with a view to securing several large factories here.

SEATTLE.—The syndicate of Syracuse capitalists who purchased the Seattle Lighting Company a short time ago has sold its interests, it is said, to a coterie of western capitalists headed by Mr. Charles G. Dawes, former controller of the currency and president of the Illinois Trust Company.

SEATTLE.—The Mutual Light & Heat Company is installing a 300-h.p. boiler with economizer and superheater. The company is now supplying heat for about 75 buildings. The officers are as follows: Mr. Charles E. Crane, president and manager; Mr. H. J. Clausen, vice-president; Mr. George Sackett, secretary and treasurer; Mr. H. R. Leigh, superintendent; Mr. O. H. Davis, chief engineer, and Mr. B. H. Leigh, chief electrician.

CHEHALIS.—A large portion of the town lights were out of commission for nearly a week recently, due to an accident to the machinery in the main plant. The crank shaft on the big engine broke and the cylinder head was blown out. Part of the lighting system is operated from the Chehalis Fir Gutter Company's plant, and this was the only current that was available for service until repairs at the main point could be effected. The plant is leased to Mr. Harry West, who has just been granted a franchise for another term of fifteen years beginning December 21, 1904. According to the terms of the lease Mr. West is to furnish the city with fifteen 2000-c.p. arc lights the first year, increasing gradually to twenty-four the fourth year; after that an arc light will be added for every increase of 300 in population, and thirty-one 16-c.p. incandescent lights are to be supplied free for the use of the city. The meter rate

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is not to exceed 12½ cents per kilowatt-hour, with discounts for quantity and hours of light to make the rate as low as 6 cents per hour. The minimum charge for private service will be $1.00 per month. It is Mr. West's intention to move the plant to Littell, four miles west of town, where an abundant supply of cheap fuel can be obtained.

WEST VIRGINIA.

RICHMOND.—The Richmond Light & Power Company has been incorporated with a capital of $25,000, to construct an electric light plant, ice factory, grist mill and pop factory. Mr. R. M. Dyer is president.

WISCONSIN.

MELLEN.—There is said to be a good opening in the village for a light and power plant.

RHINELANDER.—A 20-year franchise has been granted to the Rhinelander Lighting Company.

NORTH FON DU LAC.—The village is to be bonded for the construction of an independent lighting plant.

WAUSAU.—The construction of an electric light plant, to cost $33,000, is under consideration by the Council.

JANESVILLE.—The Council has passed an ordinance requiring that electric and telephone wires be placed underground.

BERLIN.—City Clerk Henry Morman writes that no bids were received on July 1 for lighting the city for a period of ten years.

WAUSAU.—A new water-power plant is being built and equipped by the Wausau Electric Company, of which Mr. M. Weeks is superintendent.

MENOMONEE.—Mr. W. G. Patterson has been elected manager of the Menomonee Electric Light & Power Company; Mr. T. B. Wilson is president and Mr. Alex. Hosford is secretary.

BURLINGTON.—The Burlington Electric Light & Power Company is contemplating improvements at its plant to consist of a 100-hp. engine, a 250-hp. boiler, feed-water pump and heater.

NEILLSVILLE.—The Neillsville Light & Power Company has recently been incorporated with Mr. M. J. Foot and Mr. S. M. March among the directors. The capital of the company is stated to be $20,000.

WARREN.—The lighting plant for the town is operated in connection with the manufacturing business of the George Warren Company, who furnishes current for a few private houses, the public buildings and street lights.

BELOIT.—The Beloit Electric Company has been awarded the contract for street lighting for a term of ten years at $65 per light per year for 100 lights to burn until 1 o'clock and $85 per light per year for ten lights to burn all night.

MENOMINEE FALLS.—A company is being formed for the purpose of erecting an electric plant here. Mr. F. C. Kehr, a young electrician of this place, is said to be interested in the promotion of the project. It is expected that ten arc lights will be furnished for the streets, and about 1000 incandescent lamps are already secured.

MINERAL POINT.—The officers of the Mineral Point Electric Light Company, formerly known as the Mineral Point Zinc Company, are as follows: President, Mr. D. B. Jones; vice-president, Mr. T. D. Jones; secretary and treasurer, Mr. W. A. Jones; manager and superintendent, Mr. H. S. Weil; and chief engineer and electrician, Mr. W. A. Sherman.

MILWAUKEE.—At the request of the Board of Aldermen, City Comptroller Peter Pawinski has prepared a statement showing that the cost of lighting the streets and certain public buildings during 1903 was $256,564.14. Of this amount $166,737.73 was for electric lights, $75,494.78 for gas, and $14,313.62 for gasoline lights. The purpose of this report is to show what it costs the city for light, the data to be used in a campaign for a municipal plant.

STEVENS POINT.—The Stevens Point Power Company, in which Mr. William Mainland, of Oshkosh, and Mr. Sinclair Mainland, of Green Bay, are said to be interested, recently filed articles of incorporation at Madison, stating the capital stock to be $100,000. The company will operate a water power on Wisconsin River. The property which has been secured contains 175 acres and there is a saw and grist mill on the land. A new dam is to be constructed which will give increased power, and it is expected that most of the power will be utilized at Stevens Point.

KENOSHA.—Mr. Fred W. Bowen, who for several years had occupied the position of secretary and general manager of the Kenosha Gas & Electric Company, has severed his connection with the company to accept a position in some western city, it is said. Mr. Bowen has been closely connected with the building up of the electrical industry in Kenosha, since coming to this city from Milwaukee eight years ago. He was largely interested in the installation of the new lighting system, and when the company was reorganized it was in accordance with plans formulated by Mr. Bowen. Mr. Roger N. Kimball, who is scheduled to succeed Mr. Bowen, has been connected with the business of the company for the past three years, having been closely associated with Mr. Bowen during that time.

WYOMING.

DOUGLAS.—The Douglas Light Company, which has been operating for about a year, has the contract for the city lighting on an all-night schedule. The company has a capital stock of $20,000 and is officered as follows: Mr. J. T. Williams, president; Mr. John Morton, vice-president; Mr. E. J. Swan, secretary and treasurer; Mr. F. E. Johnson, manager and superintendent.

CANADA.

NEWMARKET, ONT.—A small direct-connected unit is being installed at the municipal electric plant to carry the incandescent load after midnight.

ALVINSTON, ONT.—The Alvinston Power Company has been incorporated by Mr. A. S. Harkness, Mr. D. C. Munroe and others. The company is capitalized at $40,000.

TORONTO, ONT.—The Toronto & Niagara Power Company is arranging to erect a large fireproof sub-station on Davenport Road, bids for which have been called for.

WOODSTOCK, ONT.—It is said to be the intention of the Woodstock Electric Railway, Light & Power Company to develop a water power on the Meduxnakik River about two miles from this town.

NIAGARA FALLS, ONT.—Mr. Charles C. Egbert has been appointed mechanical engineer to superintend the erection and installation of the 10,000-h.p. turbines to be used in the wheel-pit of the Canadian Niagara Power Company.

VANCOUVER, B. C.—The British Columbia Electric Railway Company, Ltd., is changing to water power and will probably develop 30,000 horse-power, of which 3000 has already been installed. The power will be transmitted twelve miles at 20,000 volts. Mr. R. H. Sperling is superintendent of the company, and Mr. W. V. Hunt, assistant superintendent.

HAMILTON, ONT.—The City of Hamilton is making an effort to get cheaper street lighting. It now pays $85 a lamp per year, which is the highest price paid in any city in the Dominion. A clause in the present contract specifies that at the end of August, if it can be shown that the cost of producing light has been reduced since the signing of the contract five years ago, the city will then be entitled to a reduction in the price of street lighting. The city engineer figures that the cost has been reduced at least $15 per lamp by the new enclosed arc lamps alone.

KINGSTON, ONT.—On July 1 the city contract with the Kingston Light, Heat & Power Company terminated. The city will probably enter action against the company for specific performance and for possession of the plant. By arbitration the city was ordered to pay $170,000 for the electric and gas plants of the company, but the company wanted the city in addition to care for $100,000 bonds to run for thirteen years. These bonds call for 5 per cent., while the city can get money at 3 per cent. The city offers its bonds in exchange at 3 per cent., but the bondholders demur. Until the city gets possession of the plants, the streets will remain in darkness.

SHAWINIGAN FALLS, QUE.—Mr. Julian C. Smith is superintendent and operator of the plant of the Shawinigan Water & Power Company, which is one of the largest and most important power plants in the Dominion of Canada. Mr. Wallace C. Johnson is chief engineer of the company. Current is transmitted to Montreal, 85 miles distant, and to other points nearer by, for power and lighting, the operation of railways and the furnishing of power for electrochemical industries. Six thousand horse-power is now being delivered in Montreal. A second transmission line of 10,000 horse-power capacity is under construction and the amount of power delivered is to be greatly increased within the next few months. Other large power units have been arranged for at the Shawinigan Falls plant, and the new water wheels to be installed will be of 10,000-h.p. capacity, each driving a 6600-kw. generator; the wheels now in use are 6000-h.p. machines. At present the plant is capable of developing 25,000 horse-power.

MEXICO.

JIMINEZ, CHIHUAHUA.—Electric lighting and telephone systems are to be installed here, the contracts for which have been awarded to Weisel & Kok, of Parral, Mexico.

SAN LUIS POTOSI.—Dr. Paschal, Mr. W. Schuwirt and Mr. H. Garcia, of San Antonio, Texas, are reported to be interested in the establishment of an electric light and power plant in this city.

TEPIC, TEPIC.—Advices state that the owners of the Jaupa cotton mills are arranging to furnish this city with current for lighting purposes. The city has a population of 15,000 persons, and it will be necessary for the company to install considerable new generating equipment.

ZAJOTITLAN, PUEBLA.—Mr. Frank Brennan, of Mexico City, has applied for a concession which will permit of the utilization of the fall in the River Atoyac or Santa Maria Tepezintla, located in the District of Zacatlan, at a point about nine miles distant from this city. The franchise permits the use of 1500 liters of water per second, the power thus obtained being intended principally for lighting purposes.

MEXICO CITY.—The canal and tunnel for the Atlixco Light & Power Company has been completed and the plant will be ready for operation as soon as the pipe line, now in course of construction, is finished. The pipe line leading from the mouth of the tunnel will have a drop of 135 feet, and the supply of water thus obtained will generate 750 horse-power. The entire cost of the work is estimated at $150,000.

MEXICO CITY.—An order has been placed by the Mexican Light & Power Company, of Montreal, Canada, for 1500 miles of cable weighing 4,200,000 pounds, to be used on the Necaxa-Mexico City-El Oro power transmission line now in course of construction. This cable will be supported on steel towers in spans of 500 feet. The process has been patented and will supply all the power for the City of Mexico.

PUEBLA, PUEBLA.—The City Council of Puebla has extended the contract with the Compania Anonima del Alumbrado Electrico for furnishing lighting current to the city for a period of 25 years on condition that the capacity of the plant be increased and the free service of 200 arc lights be established. The company operates a water-power plant of about 500 horse-power capacity. Mr. H. S. Wilson is superintendent and chief engineer of the plant.

IGUALA, GUERRERO.—Jose Maria Volasquez and Miguel S. Macedo, of Mexico City, have received permission from the Mexican Government to establish an extensive electric power and irrigation system in the Iguala District. Power will be obtained from the Tuxpam, Lagoon, Tubpam and Amates Rivers. Application has also been made for the necessary concession from the Mexican authorities for the use of 20,000 liters of water per second from the Tomatal River, this state, for the operation of an hydraulic plant for lighting purposes chiefly.

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A PROGRESSIVE WESTERN TELEPHONE EXCHANGE.

NEW TELEPHONE EXCHANGE AT BOULDER, COLORADO.

BY H. K. SPRAGUE.

THE Colorado Telephone Company has recently completed and is now occupying a handsome new two-story building at 1327 Spruce Street, Boulder. The company had entirely outgrown its former quarters in the Masonic Temple Building, and felt the necessity not only of moving but of changing its equipment from the old-style of magneto office to the common-battery central-energy lamp signal apparatus now in vogue in the most advanced practice of the companies affiliated with Bell interests. In the new building are located the company's largest exchange in the country just north of Denver and the local business offices for the management of all the telephone traffic in Boulder and its vicinity.

The structure, which is known as the "Telephone Building," is a two-story and basement building with ground dimensions of about 60 by 30 feet. The walls are of Boulder brick, and the trimmings, Fort Collins red sandstone, the construction being of the mill type with steel reinforcement in the floor supports. An alley on the east side leading to the rear yard enables supplies to be readily brought into the store sheds by teams. The building faces the principal park in the city and is most picturesquely located, the foot hills of the Rocky Mountains lying within two or three miles of the site. All openings in the floors are surrounded by metal sheathing projecting at least 2 inches above the floor, so arranged that if the floor is flooded the cables will be protected from water flowing down between the sheathing and the floor.

The basement contains the distributing apparatus of the office, storage battery and other features which will be described later. On the first floor are the general offices, public office containing three sound-proof telephone booths for toll work, a table with newspapers, and comfortable chairs for patrons waiting for calls, public operator's desk, agent's office, toilet room, storage closets and foreman's office. The second floor contains the main operating and retiring rooms, and above it is a low attic and trap door leading to the roof. The building is heated by an Ideal sectional hot water heater connected with the chimney by a galvanized iron smoke pipe. The architect for the building was Watson Vernon, of Boulder. A notable feature is the large number of windows provided, the basement

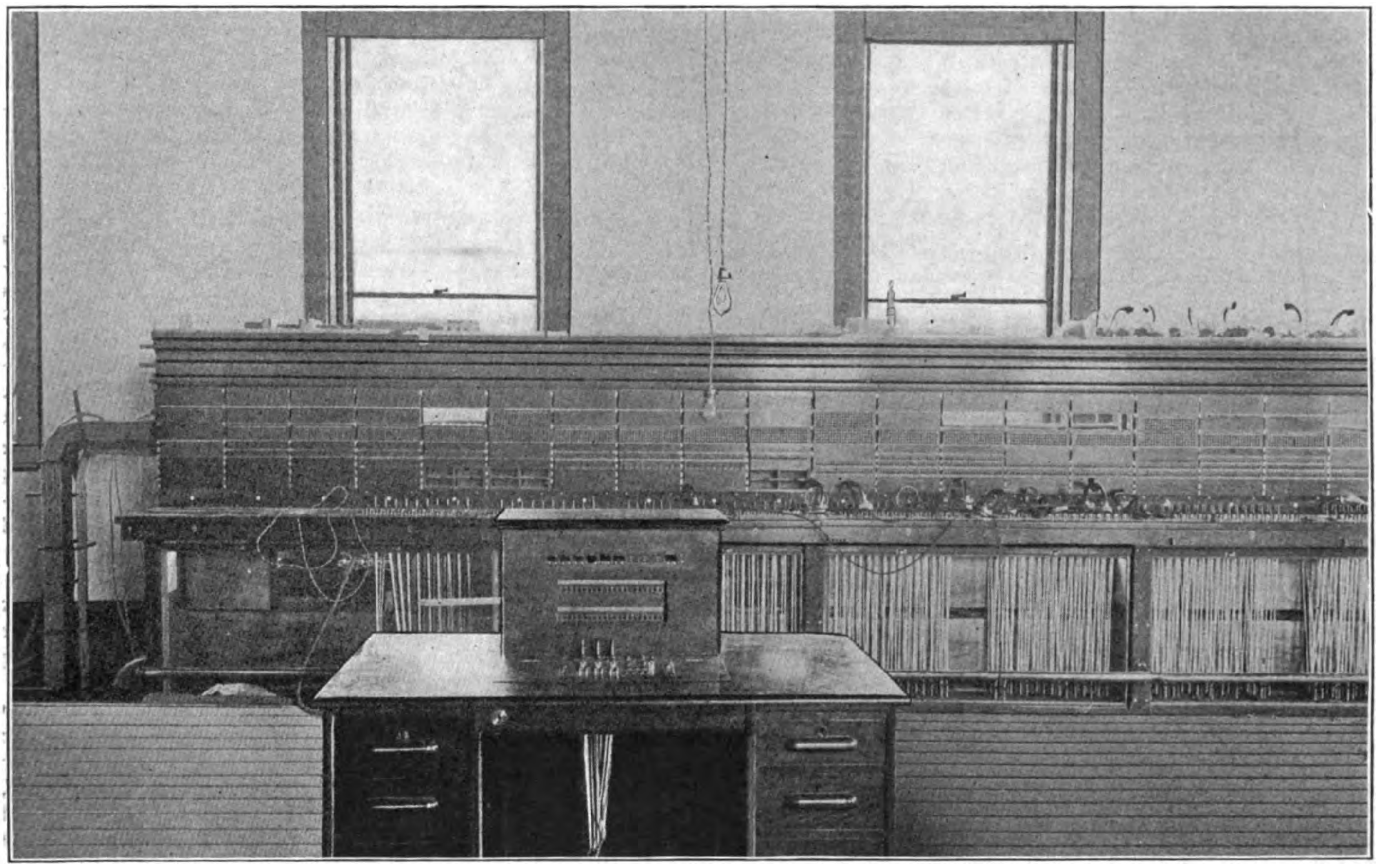

FIG. I.—TELEPHONE SWITCHBOARD OF THE COLORADO TELEPHONE COMPANY AT BOULDER, COLO.

being especially well off in the matter of daylight.

All telephone wires enter the building by four 200-pair lead-covered underground cables on the south or Spruce Street side of the basement. These cables then pass to the main distributing frame in the basement, the conductors spreading out and running up the vertical racks to the carbon protectors and heat coils. Metallic circuits are used throughout, each side of the line being protected with a carbon lightning arrester and a heat coil.

Eight shelves, with 140 pairs of terminals per shelf are provided on the horizontal side of the main distributing frame, while the vertical side has a capacity of 7 arrester bars with 100 pairs of arresters per bar. Maple channel strips for 1120 total pairs of terminals are installed on the horizontal side of the frame. The local circuits are equipped with Western Electric No. 41 heat coils, about 4 ohms each, and the toll lines with No. 4 heat coils of 40 ohms each. This frame is arranged to be extended to a capacity of 16 arrester bars. The first bar is set apart for toll lines and outgoing trunks, the remaining bars being used for subscribers' lines.

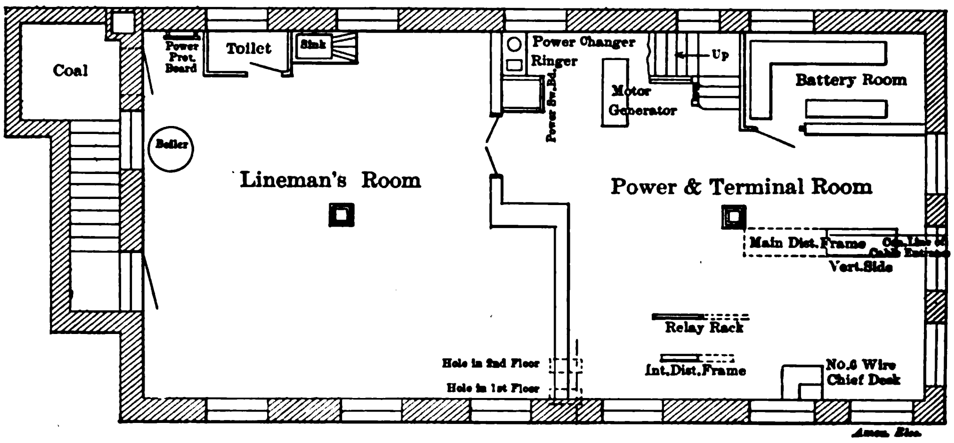

FIG. 3.—PLAN VIEW OF BASEMENT OF BOULDER TELEPHONE BUILDING.

From the verticals, the circuits are carried to the horizontal side of the frame, and there combined into 20-pair flat cables, in which form they are carried to the intermediate distributing frame. The capacity of the horizontal side of this frame is eight shelves of 100 lines per shelf, while the vertical side has five bars with a capacity of 160 lines per bar. The toll and trunk lines are mounted to allow a maximum possible growth of subscribers' lines. Adjoining the intermediate distributing frame is the relay rack, with a capacity of 800 relays. The first installation included 580 relays for subscribers' lines, 21 for toll lines, and 20 for the outgoing trunks. The subscribers', outgoing trunk and toll line relays are numbered to correspond to their associated line lamps. All of the telephone apparatus is built in conformity with the latest and most approved practice of the Western Electric Company, of Chicago. A fuse board is mounted on the frame which supports the relay rack to protect the operator's cord circuits, supervisory lamps, etc. The fuses are so arranged that when one blows a spring makes contact with a third bus-bar, ringing an alarm bell to call the attention of the trouble man. An inspector's testing table stands in the distributing room near the main distributing frame. It has one inspector's position, one cord circuit, two test line circuits to the switchboard, three in-coming trunk lines, and two trunk line circuits to the main frame. There are also a testing voltmeter, with a shunt key to reduce its resistance from 10,000 to 196 ohms for measuring low resistances, and keys for testing grounds, continuity, crosses, capacity, foreign currents, earth potentials and switchboard troubles.

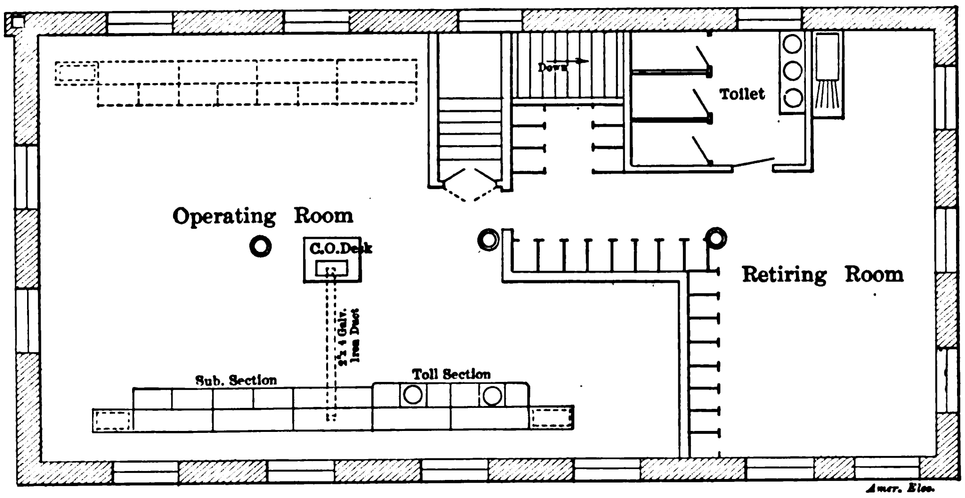

FIG. 2.—PLAN VIEW OF OPERATING ROOM OF BOULDER TELEPHONE EXCHANGE.

The power installation consists of a one-panel switchboard, a power protection panel, a Western Electric 25-ampere 36-volt generator direct-connected to a 2-h.p., 110-volt direct-current motor, a 16-cell storage battery, ringing machines, etc. Power is regularly obtained from the 110-volt lines of the Boulder Light & Power Company. The 110-volt alternating current of the same company enters the telephone building at the attic level on the north side, and supplies the incandescent lamps throughout the offices. Rubber-covered wire is used throughout the building. The ringing dynamotor is a 35-watt Western Electric machine, with a 110-volt primary and a 75-volt secondary. The power switchboard consists of a single slate panel mounted in the distributing room. It contains one Jewell volt-ammeter, baby size, ampere scale 0 to 50, central zero, volt scales 0 to 50 and 0 to 5, a 45-ampere single pole underload I. T. E. circuit breaker, five switches, a generator field rheostat, two starting boxes, one 200-ampere fuse, a 35-ampere fuse, two 2-ampere fuses for the pole changer, two 25-ampere D. & W. fuses for the charging generator, two similar fuses for the charging motor, and two 4-ampere fuses for the ringing dynamotor. The pole changer is a Warner machine, and it runs at night time after the dynamotor has been shut down. It is located on the same shelf as the dynamotor. There is also a power protection panel in the building near the point where the 110-volt direct-current circuit enters. It contains one double-pole, single-throw switch, two 30-ampere D. & W. fuses, two General Electric M. B. telephone-type lightning arresters, and four Western Electric reactance coils. The storage battery consists of sixteen of the Electric Storage Battery Company's type "F-11" chloride accumulators set on a special cupboard in a small battery room just off the main distributing room. The battery room is about 13 ft. long by 6 ft. 8 ins. wide, and the discharge rate of the cells on the 8-hour basis is 50 amperes. Glass tanks are used, set in trays filled with sand. Adjoining the terminal room is the linemen's room, containing the heater and various shelves for storage purposes.

From the relay rack the three-wire telephone circuits pass up through the general office floor to the main operating room by an enclosed wooden cable way. The operating room is 40 ft. 4 ins. long and 27 ft. 2 ins. wide for most of its length. At the east end of the room is a stairway leading to the street floor.

The main or subscribers' switchboard is located in straight sections on the west side of the room. It is a standard local relay, multiple, central-energy, lamp-signal board, Western Electric Company's No. 8 pattern, and consists of five 5-panel two-operator sections. Each section is 5 ft. long, the toll portion of the board occupying a space 10 ft. in length, and the local or subscribers' section, a space 15 ft. long. The total length of the switchboard, including the cable openings at each end, is 30 ft. 4 ins. A passageway 2 feet wide extends the entire length of the board on the wall side.

The ultimate capacity of the board is 1500 lines and 200 outgoing and local trunk multiple jacks. The operating installation covers 600 subscribers' multiple jacks, 40 toll and recording trunk multiples, 40 outgoing and local trunk multiples, and there are 100 answering jacks in use per subscribers' position, 200 being the ultimate capacity. There are 7 answering jacks per toll operator's position, 580 total subscribers' answering jacks, 21 toll line answering jacks and 20 two-way trunk jacks. Fifteen subscribers' cord circuits are installed per position, this being the ultimate capacity of the board. There are four through cord circuits for each toll operator's position, and six local cord circuits. There are also provided four local switching trunks, two test line circuits and one instruction circuit. The night bell circuit is mounted in the rear of the third section of the switchboard. Enough jacks are provided in the trunk multiple for 20 outgoing trunks. A key is also supplied to throw the last toll and first local positions together for night work. Enough cable is provided to enable the present No. 8 board to be replaced by a Western Electric No. 1 board when the growth of traffic requires it. The No. 1 board is the type used in the company's main office in Denver, and has a capacity of 9600 lines; it is called an "A" or subscribers' operators' board, and incoming trunking is done over a separate or "B" board. Space for the installation of a "B" board and a toll board is provided at the east side of the Boulder operating room. The subscribers' lines and direct recording trunks are multipled at all toll sections, and the toll lines themselves are multipled also. All exposed woodwork on the front of the switchboard is mahogany.

In the center of the operating room is the chief operator's desk. It is equipped with one operating position, three local cord circuits, four trunk circuits, four local switching trunk circuits, ten monitor circuits to the switchboard, and one instruction circuit. This desk is equipped for two-party line ringing. The chief operator's principal duties are: general supervision of the operating and operating room force; distribution of operators' loads; answering requests for charges; handling inquiry and duplicate calls; handling "appointment" and "leave word" calls; handling complaints, and the distribution of through calls. No supervisor's stands are provided, the exchange not being large enough to require the service to be watched by more than one supervising operator. At the right of the chief operator are two card indices. One index contains the names and addresses of subscribers, arranged numerically according to their telephone numbers. The other index is frequently not found in even large telephone exchanges. It is indexed alphabetically by streets and numerically by street numbers under the different subscribers' stations. This index is used to supply information as to the name or telephone number of a party living at a certain address. The company has many calls a day from people who have remembered the addresses of subscribers but who have not in mind the person's name or his telephone number. The company's ability to supply this information has been a great convenience to subscribers. There is also the usual alphabetical telephone book at the chief operator's desk, kept up to date by pencil insertions through the quarter years. Often a subscriber desires to find out the nearest telephone to a certain street number which has no telephone itself, and the index furnishes this information at a glance. The index was, however, not equal to the recent request of a subscriber who desired a connection with a party, name, telephone number and address unknown, "who lived in a yellow house on Blank street." Perhaps if the cards had been colored to correspond with all the shades and tints of a mile or two of different residences the subscriber's lapse of memory might have been overcome without the unwarrantable delay of repeating every name and number on the street. Many fire alarm calls in Boulder are given through the telephone office.

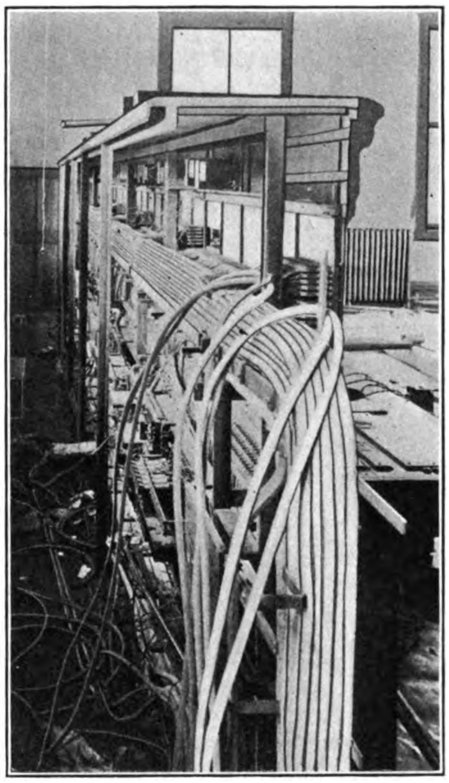

FIG. 4.—REAR VIEW OF TELEPHONE SWITCHBOARD.

The handling of toll calls is an interesting feature of the Boulder exchange. When the subscriber wants a long-distance connection he removes the receiver from its hook; the "A" or subscriber's operator at the local station of the board plugs into the subscriber's answering jack and asks, "Number?" The subscriber asks for a toll connection, and the "A" operator tests the small bank of recording trunks which form part of her trunk multiple, and selects an idle trunk. In its jack she inserts the other plug of a pair of cords, thus lighting a calling-in lamp at the recording toll operator's position and connecting the subscriber with the toll section of the switchboard. The toll operator answers her signal lamp by plugging in with one cord of a pair, and finding the subscriber on the line, records his call. Just before the completion of the recording, and incidental to it, the toll operator checks the number given to her by the subscriber, taking it up on another cord in the multiple before her, using this new line of connection in repeating to the subscriber the information which she has placed upon the ticket. Any error in number must at once be discovered in this way, after which the second cord is disconnected. The toll operator then tells the subscriber that he will be called as soon as the connection is completed, after which the subscriber "hangs up" his telephone, lighting the supervisory disconnect signal at the "A" position. The toll operator finishes writing the ticket and then removes the answering plug from the original recording trunk, thus setting the second supervisory signal at the "A" position. This signal is treated by the "A" operator as a peremptory disconnect signal, even if the subscriber prevents the disconnect signal, etc., from lighting by removing his telephone receiver from its hook or leaving it unhung. The "A" operator then clears the original connection. Upon the completion of the call, the toll operator plugs into the subscriber's jack in the multiple before her, and calls him, stamping the ticket with a calculagraph at the beginning and end of the conversation. At the end the toll operator disconnects. All inward calls from outside exchanges are completed directly in front of the toll operator in the desired subscriber's multiple jack.

On the second floor is also the operators' retiring room, containing lockers, couches, easy chairs and a gas heater for making coffee. There is a well-appointed toilet room adjoining the retiring room.

As regards fire risks, the building is in excellent condition. There are very few dark corners; oil is stored in small quantities outside the building; water faucets are located in the east and west walls on the outside, and the electric wiring is very carefully done. "Swan" dry powder fire extinguishers are hung in conspicuous places throughout the building, and gas lights and candles are available in the operating room in case the supply of electricity fails. The company has various additional precautions under consideration, such as the provision of rubber hose fire insulating barriers in the main switchboard between the main cord shelf and the multiples, asbestos or woolen blankets for the operating room, additional extinguishers, fire shutters, etc. It has also been suggested to fill two pairs of bellows with fire extinguishing powder and hang them on the wall behind the switchboard, on the ground that the powder could be much more readily directed in case of fire than when it is thrown from a tube.

The Boulder office is handling something like 10,000 calls per day at present. At the time of writing there were 1031 subscribers connected to the Boulder office, 405 of the stations being business and 626 residence 'phones. The population of Boulder is about 10,000, including the towns of Longmont and Lyons, to which free two-way trunking is allowed; there are 1723 stations connected to the exchange. One-way free trunking is allowed to Niwot, Marshall, Erie, Superior, Louisville and Lafayette. The toll rate to Denver is 25 cents day or night, on the three-minute basis, and the traffic is handled by four circuits, three being No. 10 B. & S. copper wire and the other No. 12. The distance is about thirty miles, and the toll service is so quick between Boulder and Denver that it has earned the name of the "rapid fire" circuit. A call has been put through in 15 seconds, and it is usually unnecessary for a subscriber to hang up his telephone in calling any Denver number. This speed is accomplished by carrying the toll lines from Boulder direct to the main subscribers' switchboard at the Denver main office, located on Champa Street, so that a call from Boulder is handled by the Denver local operator almost as quickly as a call originating in Denver itself. Between Boulder and Lafayette is a toll circuit of No. 12 copper and also a No. 12 iron trunk line. Another trunk line is to go in at once between Boulder and Erie, and two No. 14 iron trunks between Boulder and Broomfield, in addition to the two No. 12 iron trunks now in operation. The main toll line between Denver and Cheyenne, Wyo., a circuit of No. 8 B. W. G. copper wire, connecting the Colorado Telephone Company's lines with those of the Rocky Mountain Bell Telephone Company on the way to Salt Lake City, passes through this district. An interesting circuit tributary to Boulder runs to Ward (26 miles by rail), in the heart of the Rockies at an altitude of about 9400 feet. This is of No. 12 B. & S. copper, continuing No. 14 iron from Ward to Eldora. A No. 12 B. & S. copper circuit runs from Boulder to Germantown, with a branch at Sunshine, Gold Hill and Watt Street, and thence to Sugar Loaf by No. 14 iron wire. All this region is noted for mining and for mountain scenery, while to the north and east of Boulder are many fine ranches supplied with telephone service. There are no private branch exchanges or drug store pay stations in Boulder. The system was cut over from magneto to common-battery service in the new office on January 3 of this year. Eight party-line circuits are in use for miximum distribution. The wires in the business district are now largely underground.

The rates at present in force in Boulder are eight-party business telephone, $30 per year; two-party line, per instrument, $48; one-party line, $60; residence telephone, eight-party line, $18; two-party line, $30; one-party line, $42.

Colorado has more toll lines per capita than any other state outside of New York. The lines of the company radiate from Denver, Colorado Springs and Pueblo, giving service to all the important towns and mining camps in the state, as well as to Montana, Wyoming, New Mexico and Utah. Every type of line construction is encountered, from lines crossing the Continental Divide in submarine cables at an elevation of nearly 14,000 feet to city to ranch lines involving problems far different from those solved in the mountains. Within the past year or so common-battery offices have been established in Pueblo, Salida and Trinidad, besides Boulder and Denver, while Colorado Springs was one of the first places in the West to be equipped with the central-energy system. Fort Collins and Grand Junction will probably be cut over to the common-battery system by the time this article is printed. Although the Colorado Telephone Company's system crosses the southern boundary of the state at two points and almost crosses the eastern and western boundaries, it has but one connection with other systems, that being at Cheyenne as stated before.

The writer's thanks are due to the following officials for courtesies and data: E. B. Field, president; H. A. Rhodes, chief engineer; G. E. McCarn, assistant engineer; W. L. Cozad, traffic manager, and W. E. Kitterman, agent of the company, in charge at Boulder.

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THE ELECTRIC POWER FIELD.

BY GEORGE E. WALSH.

The transmission of electricity over great distances at less cost and waste than ever before is rapidly increasing its sale to power plants in cities. Small consumers naturally look to the large electric power companies for their current, but the tendency of large consumers to purchase power "in bulk" is also very apparent. The average factory, mill or other plant not equipped for generating electric power finds as a rule that it is more economical to purchase the current from some outside company. Large manufacturing plants are the best purchasers of electric power, and the number of these who depend upon outside electric power increases each year. The large sellers of electric power established at Niagara, Massena and Sault Ste. Marie first encouraged this new field, and they are to-day supplying scores of factories and mills with low-rate power sold according to the amount used. By charging a very small price for power used in large quantities, the companies have stimulated the growth of whole groups of factories along the line of their transmission.

But in other parts of the country the effort to produce electricity for supplying factories and mills has only in recent years met with any encouragement. In New England, where the boot and shoe factories are very numerous, the purchase of electric power for operating their machines is still small, probably not more than 500 horsepower being thus used. The same is true of the woolen and cotton factories of New England. Most of the few that have adopted electricity for their motive power have established their own generating plants. One woolen factory, however, near Springfield, Mass., has found that it pays better to purchase electric power from outside sources than to establish a plant of its own.

In a recent investigation of the subject it was found that some thirty odd sellers of electricity for power purposes supplied over 330 metal-working shops with current on a large scale, 175 wood-working factories, 48 cotton factories, 375 printing establishments, and 27 boot and shoe factories. None of these plants used more than 500 horsepower, and the cost of operation varied greatly; but in nearly all instances the companies reported a reduction in expenses by the substitution of electricity when purchased outside.

The construction of large steam-driven stations for supplying electricity in large towns and cities has tended toward the introduction of new industrial factors that promise revolutionizing results almost as great as those produced by the harnessing of Niagara. The fuel problem is becoming more difficult of solution every year in many localities. Factories and mills have had to move away from towns and cities where they were suitably located as to markets and supply of raw material, owing to the high cost of coal and inconvenient delivery. Moreover, the great amount of coal storage room required in a city, where land is costly, makes steam-operated plants expensive, and many are to-day considering the question of moving or purchasing electric current. Steam-driven electric stations located just without city limits offset these unfavorable conditions, and in many instances they offer ideal results. Certain kinds of manufacturing plants prefer town sites, and they must consider the cost of land carefully.

It is for this reason that so many printing establishments have utilized electricity for operating presses and other machinery. The printing plants must of necessity be near the commercial centers, and the trouble and expense of supplying them with coal tax their resources severely. With electricity transmitted from some central station at wholesale rates the cost of operating has been found to be less than by steam. The saving in space and cleanliness is even more conspicuous.

Metal-working shops likewise find electricity of commercial value to them. In this case it is not so much that the plants must be located in the large business centers, but owing to the great number of small machines to be operated electricity is the only power that can give the highest results. With individual motor drive the workmen have better control of their tools and the best results are obtained at less outlay.

The ability to make low rates for manufacturing purposes is easily solved along large water courses, but the plants wishing to purchase electricity are not always conveniently located for utilizing it. Long-distance transmission is thus one of the important factors in this class of work. The Western power companies have apparently solved this question satisfactorily. The Washington (Spokane) Water Power Company sends current over a distance of 110 miles for commercial purposes, selling power to dozens of plants and manufacturing companies along the line of transmission. This long-distance plant supplies mines chiefly with power at rates far less than could be made by any independent company operating in the mines, or by any plant run by the different companies for their individual use. Both at the Standard and Hecla mines there are operated four General Electric 300-h.p. induction motors to drive compressors and hoists. At the present writing all the power generated by the plant is sold to individual mines, and satisfaction is obtained on both sides.

Another electric power plant is selling power at a distance of 140 miles from its generating station. This plant is located at Colgate, Cal., and its line of transmission is from the high mountainous regions to the shores of San Francisco Bay, 140 miles distant. Throughout its whole length there are mills, factories, mines, smelters and lighting and railway plants purchasing the current. Numerous other water power plants send their power great distances with financial success both to themselves and the purchasers. The one at Shawinigan Falls, Montreal, has a transmission line 83 miles long and the one at Canon Ferry, on the Missouri River, finds customers 65 miles distant.

The question of supplying mills and factories with electric power at low rates when they are located outside of what may be called the water power zone offers difficulties the solution of which is greater than those presented elsewhere. There is a limit to long-distance transmission, for there is nothing more certain than that a point must eventually be reached when the current cannot be transmitted any farther without too great a cost. The sale of power on a large scale and at little cost is really more important to the commercial world beyond the region of water power than within that zone.

Steam-driven stations for supplying electric power on a large scale are already working satisfactorily in some parts of the country. At Montreal, for instance, a steam-driven station used for lighting purposes recently entered the power field, and is now selling to a cotton factory power to operate motors aggregating over 3,400 horse-power. This factory has, since its change of power, reduced the cost of operation and found the purchase of power from an outside generating company eminently satisfactory.

Steam-driven stations can never compete with water power stations in long-distance transmission, nor is it necessary, but it is quite evident that companies can work the field of generating electric power for customers in manufacturing centers without fear of loss, and with a certainty of profit. Heretofore the plants selling electricity in such regions have been railway systems or electric lighting plants, which found that they had some surplus energy that they could dispose of profitably. Such plants cannot operate in all parts of the country. In many of the New England States their charters forbid them to sell power. There is a prejudice against increasing their rights in this respect, and manifestly the only solution of the problem is for companies to enter the field to manufacture power for general distribution, as the water power companies have done around Niagara and Massena, and on the Pacific coast.

THE REPULSION MOTOR.

BY A. S. M'ALLISTER.

Much has appeared recently in technical literature concerning the performance of the repulsion motor, and almost every writer on the subject has brought forward a different mathematical theory of the properties. The present writer has no intention of attempting to produce an additional theory or to add to the information on the subject. It is believed, however, that there is yet room for a treatment which will allow of the investigation of the inherent characteristics of the repulsion motor in a manner so simple as to be readily comprehended, and one which is devoid of the usual array of mathematical symbols which are of use only to him who wishes to design such a machine.

The repulsion motor is a transformer, the secondary core of which is movable with respect to the primary, and the secondary coil of which remains at all times short-circuited in a line inclined at a certain angle with the primary coil. Such a machine is represented diagrammatically in Fig. 1. Superficially considered, current which flows in the secondary (the armature) by way of the brushes acts upon the field produced by the primary current to give the armature a torque which retains its direction with the simultaneous reversal of the two currents. If the brushes were placed in line with the field poles, maximum current would be produced in the secondary, but it would have no tendency to move because such torques as are produced on one side of the armature would be opposed by those produced on the other. Similarly, if the brushes were placed at right angles to the field axis no torque would be obtained, for no current would flow in the secondary. A further analysis will show that the torque depends directly upon the product of the secondary (armature) current and that part of the field magnetism which is in mechanical quadrature with the radial line joining the secondary brushes and which is in time-phase with the armature current. In fact, the torque follows a law similar in all respects to that which holds for direct-current machines.

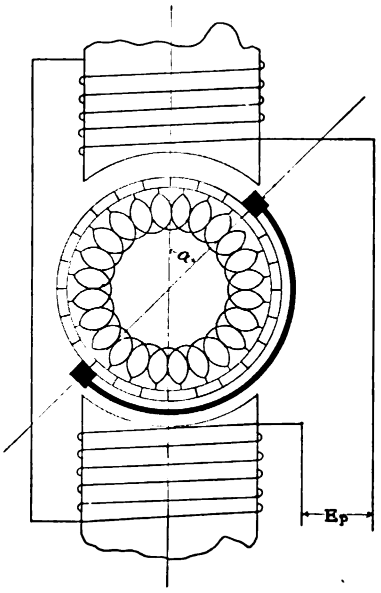

FIG. 1.—CIRCUITS OF REPULSION MOTOR.

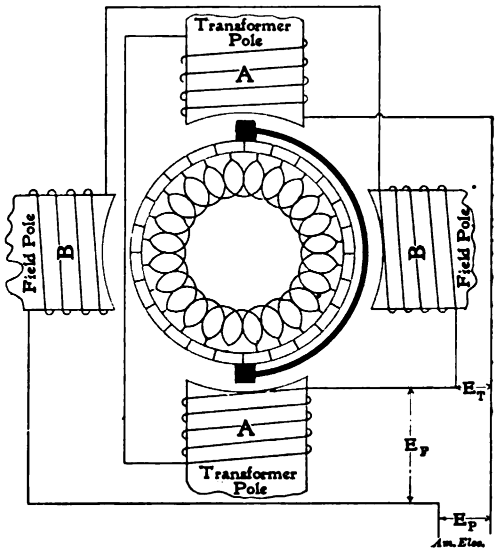

FIG. 2.—CIRCUITS OF IDEAL REPULSION MOTOR.

For the purpose of analysis, it is convenient to divide the primary magnetism into two components, one in mechanical quadrature with the line of the brushes, to give the torque, and one directly in line with the brushes, which produces current in the secondary by transformer action. In commercial repulsion motors the primary winding is distributed over an approximately uniformly slotted core without the projecting poles shown in Fig. 1, and the assumption is made that any given angle, α, to which the brushes are shifted from the field line, the flux component in line with the brushes is $\Phi \cos \alpha$, and that in quadrature is $\Phi \sin \alpha$, where Φ is the total primary flux. This assumption is more or less justified by the fact that when no current flows in the secondary, such component values of fluxes give a resultant equal to the primary flux and having the proper mechanical position on the core. As will appear later, however, this assumption leads to error in assigning values to the two flux components. In order to eliminate all trouble from this source and to allow the conditions to be clearly presented, it is well to divide the primary winding up into two parts placed upon two projecting cores in mechanical quadrature one with the other, and to locate the brushes in line with one core, as shown in Fig. 2. As the simplest possible case, it will be assumed that the number of turns on one core is the same as on the other and equal to the effective turns on the armature. Under the conditions assumed, when no current flows in the secondary the primary field would have a resultant located 45° from the line joining the two brushes.

If the secondary brushes be connected together while the rotor is stationary, the transformer action of the flux in *A* will cause a current to flow in the secondary, which current tends to reduce the flux in *A* and allow more current to flow in the primary coil and to increase the flux in *B*. If the transformer action were perfect, no flux would remain in *A*, while the flux in *B* would assume double value and the current in the secondary would equal that in the primary (the primary and secondary turns at *A* being equal). Such a condition would exist if the primary and secondary coils were devoid of resistance and local reactance (magnetic leakage).

Primary resistance and local reactance at *A* being negligible, when the rotor is stationary the e.m.f. across the coil on the core *A* will be zero, while that on *B* will be equal to the total impressed e.m.f. Assume that the core material at *B* and through the armature is such that the flux produced is in time phase with the current in the coil and proportional at all times to such current; that is to say, that the reluctance of the magnetic path of *B* is constant. Let it be further assumed that the reluctance of the magnetic circuit of *A* is equal to that of *B*. It should be noted that these assumptions are equivalent in all respects to those which are invariably implied in a mathematical or graphical treatment where the coefficient of self-induction, *L*, is taken as constant.

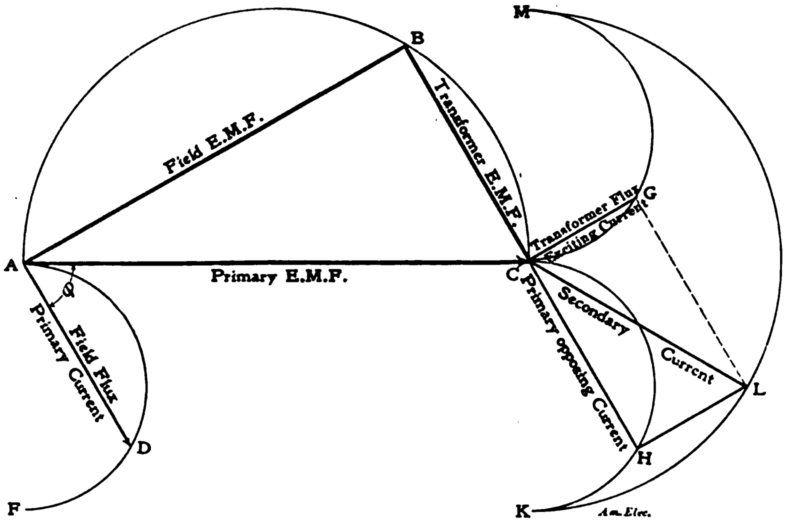

FIG. 3.—DIAGRAM OF IDEAL REPULSION MOTOR.

TABLE I.—Calculation of Performance of Ideal Repulsion Motor. E.M.F. = *E* = 100 volts; Inductance of Field Coil = X_f = 10 ohms.

For all positions of brushes.					Brushes at tan—¹ = 1.						Brushes at tan-¹ = .25.					
1	2	3	4	5	6	7	8	9	10	11	6′	7′	8′	9′	10′	11′
$B \sin\theta$	$E \cos\theta$	$\frac{1}{X_f}$	$\cos\theta$	B 3, 4	$\frac{2}{1}$	$\frac{5}{6}$	$\frac{7}{E\ 3}$	—3	$\frac{2}{X_f}$	$\sqrt{9^2+10^2}$	$\frac{2}{4\ 1}$	$\frac{5}{6'}$	$\frac{7'}{E\ 3}$	—3	$\frac{2}{4xf}$	$\sqrt{9'^2+10'^2}$
E.M.F. of field. E_f	E.M.F. of trans. E_t	Primary current. I_p	Primary P.F. $\cos\theta$	Pri. watts. W_p	Speed. S	Torque. T	Torque effic'y. T/I_p	Components of secondary cur. I_p	I_{ft}	Sec. cur. I_s	Speed. S	Torque. T	Torque effic'y. T/I_p	Components of secondary cur. I_p	I_{ft}	Sec. cur. I_s
100.00	0.00	10.000	.0000	00.0	0.0000	1000.0	100.0	10.000	0.000	10.00	0.0000	4000	400.0	10.000	0.000	10.00
99.62	8.716	9.962	.0872	87.0	0.0875	992.0	97.0	9.962	0.872	10.00	0.0219	3968	398.5	9.962	0.218	9.97
98.48	17.36	9.848	.1736	170.5	0.1763	965.0	98.5	9.848	1.732	10.00	0.0441	3860	393.9	9.848	0.434	9.86
96.59	25.88	9.659	.2588	250.0	0.2679	932.0	96.5	9.650	2.588	10.00	0.0671	3728	386.4	9.659	0.647	9.68
93.97	34.20	9.397	.3420	321.0	0.3640	882.0	94.0	9.397	3.420	10.00	0.0910	3528	375.9	9.397	0.855	9.42
90.63	42.26	9.063	.4226	383.0	0.4663	820.0	90.6	9.063	4.226	10.00	0.1166	3280	362.5	9.063	1.057	9.13
86.60	50.00	8.660	.5000	433.0	0.5774	750.0	86.6	8.660	5.000	10.00	0.1444	3000	346.4	8.660	1.250	8.75
81.92	57.36	8.192	.5736	470.0	0.7002	670.0	81.9	8.192	5.736	10.00	0.1751	2680	327.7	8.192	1.434	8.31
76.60	64.28	7.660	.6428	491.5	0.8391	585.0	76.6	7.660	6.428	10.00	0.2098	2340	306.4	7.660	1.607	7.85
70.71	70.71	7.071	.7071	500.0	1.000	500.0	70.7	7.071	7.071	10.00	0.2500	2000	282.8	7.071	1.768	7.31
64.28	76.60	6,428	.7660	491.5	1.192	412.0	64.3	6.428	7.760	10.00	0.2980	1648	257.1	6.428	1.915	6.71
57.36	81.92	5.736	.8192	470.0	1.428	328.0	57.4	5.736	8.192	10.00	0.357	1312	229.4	5.736	2.048	6.09
50.00	86.60	5.000	.8660	433.0	1.732	250.0	50.0	5.000	8.660	10.00	0.433	1000	200.0	5.000	2.165	5.46
42.26	90.63	4.226	.9063	383.0	2.145	178.0	42.3	4.226	9.063	10.00	0.536	712	169.0	4.226	2.266	4.78
34.20	93.97	3.420	.9397	321.0	2.747	117.0	34.2	3.420	9.379	10.00	0.687	468	136.8	3.420	2.349	4.15
25.88	96.59	2.588	.9659	250.0	3.732	67.0	25.9	2.588	9.659	10.00	0.933	268	103.5	2.588	2.415	3.54
17.36	98.48	1.736	.9848	170.5	5.671	30.2	17.4	1.736	9.848	10.00	1.418	121	69.4	1.736	2.462	3.02
8.72	99.62	0.872	.9962	87.0	11.43	7.6	8.7	0.872	9.962	10.00	2.86	30	33.9	0.872	2.491	2.63

The production of torque at the rotor can now be investigated. The flux in *B* is in time phase with the primary current, while the current in the armature is in phase opposition to that in the coil on *A*. Therefore, the armature current is in time phase with the field magnetism, and the torque (the product of the two) retains its sign as the two reverse together. If the armature be allowed to move, a certain e.m.f. will be generated at the brushes due to the fact that the armature conductors cut the field magnetism of *B*. This generated e.m.f. will at each instant be proportional to the product of the field magnetism and the speed, and will, therefore, be in time phase with the magnetism of *B*. Since the resistance and local reactance of the armature circuit are negligible, any unbalanced e.m.f. at the brushes would cause an enormous current to flow through the armature. Such current, however, would produce a flux in time phase with itself and the rate of change of the flux would generate an e.m.f. opposing the effective e.m.f. which causes current to flow, the final result being that there flows just that amount of current, the magnetomotive force of which produces a value of flux the rate of change of which through the armature generates an e.m.f. equal and opposite to that due to the speed. Now, the flux thus produced alternates through the winding on *A* and generates therein an e.m.f. equal to that similarly generated at the brushes and in time phase with the brush e.m.f. Since the flux at *B* is in time phase with the e.m.f. across the winding on *B*, and the e.m.f. counter-generated in the winding on *A* is in time phase with the flux in *B*, the e.m.f. across the winding *B* is in time quadrature to that across the *A* winding. The vector sum of the e.m.f.'s at *A* and at *B* must be equal to the constant line e.m.f., *E*.

The facts just stated lead to the very simple graphical representation of the phenomena of an ideal repulsion motor shown in Fig. 3, where *A C* represents in value and phase the impressed e.m.f., *E;* the line *A B* equals the e.m.f. across the winding, *A*, at a certain armature speed, while *B C* is the corresponding e.m.f. across *B* at the same speed. It will be noted that since at any speed the e.m.f's *A B* and *B C* must be at right angles and have a vector sum equal to *E*, the locus of the point *B* is a true circle and can at once be drawn when *A C* is located. Since the e.m.f. of the *A* winding is proportional to the value and rate of change of the flux in the core *A*, and such flux is proportional to the current in the coil, the current in the winding, *A*, is proportional to the e.m.f., *A B* (Fig. 3) and in time quadrature to it, as shown at *A D*. A little consideration will show that the locus of *D* is a true circle having a diameter *A F* equal to the primary current at standstill.

It has been stated that at starting the primary and secondary currents were equal in value, but that under speed conditions another current was produced in the secondary. The value of this additional component of the secondary current, which must be such as to give the magnetism in *A* (Fig. 2), may be found as follows: The magnetism in *A* is proportional to the e.m.f. across the winding of those poles. Hence, the current to produce such magnetism must be proportional to the e.m.f. and in time quadrature to it; or, if in Fig. 3 *B C* is the e.m.f. just referred to, *C G* is the component of secondary current to produce the corresponding flux. The locus of *G* is a true circle with a diameter equal to *A F* of the primary current, as will be apparent from what has been stated previously. The vector sum of the components, *C G*, of the secondary current and *C H*, equal and opposite to the primary current, gives the true secondary current both in value and phase position.

It is evident that at a certain speed the e.m.f's represented by the lines *A B* and *B C* in Fig. 3 will be equal in value. It is interesting to note what occurs at this speed. Since the e.m.f's generated are equal and in time quadrature, the magnetic fluxes must similarly have equal values and be in time quadrature. It will be recalled that the magnetic condition at this speed is similar in all respects to that found in two-phase induction motors; that is, there is produced a true uniform rotating field (if a continuous core be used) moving at "synchronous speed." At other armature speeds there is produced similarly a revolving field traveling at synchronous speed, but the field varies in intensity from instant to instant, giving what is termed an "elliptically revolving" field, one axis of the ellipse remaining in line with the brushes and having a value proportional to, but in time quadrature with, the e.m.f. of the winding of *B*, Fig. 2, or length *A B* in Fig. 3, the other axis being in line with the field poles, *A*, and proportional to the e.m.f. across the winding on them, *B C*, in Fig. 3. It is noteworthy that such an elliptical field is also characteristic of the magnetic condition found with single-phase motors. It should be carefully noted, however, that the term "synchronous speed" refers to the change in position on the core of the maximum magnetic flux existing at each instant and has no direct bearing upon the maximum speed which the rotor may attain, which maximum speed, in fact, is limited by conditions other than those here assumed to exist.

By the use of Fig. 3 the complete performance of an ideal repulsion motor may be determined if values be assigned to the scales chosen for the current and e.m.f. Table I records such calculations of the performance of a certain repulsion motor, of which the field reactance is 10 ohms when operated at a constant impressed e.m.f. of 100 volts; that is, in Fig. 3, $A C = 100 \ V.$, $A F = 10 \ A$. The method of making computations is indicated at the head of each column of the table. It will be observed that there have been chosen certain values of the e.m.f's across the field coils on the poles *B* (Fig. 2) and the corresponding values of the e.m.f's across the transformer coils on the poles *A* have been calculated.

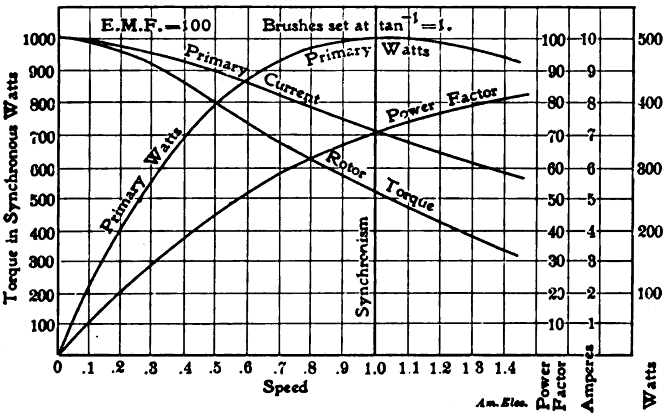

FIG. 4.—CHARACTERISTICS OF IDEAL REPULSION MOTOR.

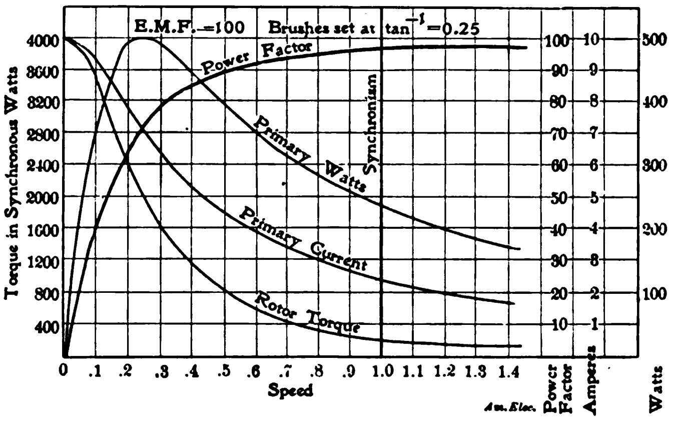

FIG. 5.—CHARACTERISTICS OF IDEAL REPULSION MOTOR.

As will be seen, the work of determination has been much simplified by assuming e.m.f. values corresponding to the product of the impressed e.m.f. and the sine and cosine values of angles at five-degree intervals, so that almost all values recorded in Table I have been taken directly from trigonometric tables.

The speed is found as follows: With an equal number of turns in the windings on *A* and *B* of Fig. 2, when the e.m.f's across these windings are equal, the speed is synchronous, and this speed is given the value 1. Now, at other speeds, the e.m.f. across the *A* winding will be proportional to the product of the speed and the flux in *B*; that is, the e.m.f. in the winding, *B*, as shown previously. It will be apparent, therefore, that the speed is the ratio of the e.m.f. across the coils on *A* to that across the coils on *B* of Fig. 2, or to the ratio of the lengths *B C* to *A B* in Fig. 3. It will be noted that this ratio is the cotangent of the angle *A C B* arbitrarily chosen at five-degree intervals, so that the speed may be taken at once from trigonometric tables. The torque is expressed in synchronous watts, as the ratio of output to speed.

Columns 6 to 11 of Table I have been calculated on the assumption that the brush angle a of Fig. 1 was 45°, or what is the same, that the number of turns on field poles *B* was equal to that on the transformer poles, *A*, Fig. 2, and these calculations are graphically represented in Fig. 4. In Fig. 5 are given the characteristics of an ideal repulsion motor with the brush angle a of Fig. 1 having a value such that its tangent is 0.25, and the calculations recorded in columns 6′ to 11′ are based on this assumption. The conditions here assumed are equivalent to what would be obtained if the number of turns on the field poles, *B*, were 0.25 of the turns on the transformer poles, *A*, Fig. 2. It is further assumed that the coils on poles B are the same in number as previously; that is, that the field reactance is 10 ohms as before, and that the turns on both the armature and transformer poles have been increased to four times their first value.

The method of calculation is quite the same as before, but perhaps a word is needed as to the calculation of the speed and secondary current. At synchronous speed, the magnetism in the field poles, *B*, is equal to that in the transformer poles, *A*, as noted above. Due to the increased number of turns on the transformer poles, at synchronous speed, the e.m.f. across the coils on *A* will be four times that across the coils on *B*, Fig. 2. A consideration of this fact leads to the conclusion that the speed is all times equal to one-fourth of the ratio of *B C* to *A B* in Fig. 3; that is, the speed is equal to one-fourth of the cotangent of the angle Θ, arbitrarily assumed, and hence may quite readily be computed.

The component of secondary current to counterbalance the primary current is equal and opposite to the primary current, since the armature turns are equal in number to the transformer turns on *A*; but the current to produce the magnetism in the transformer poles under speed conditions will at all times be one-fourth the value required to produce the same magnetism in the field poles, as will be seen from column 10′ of the table.

A comparison of the curves of Fig. 4 with those of Fig. 5 will reveal the effect of shifting the brushes from the 45° position farther toward the axial line of the transformer poles. It is essential for good performance that the angle of brush shift from the transformer position be quite small, usually from 12 to 16°, depending upon the constructive constants of the machine.

It must be very carefully noted that the curves here given are for an ideal repulsion motor, all resistance, local inductance and short-circuiting effects having been neglected, and that such curves cannot be realized in practice. It is worthy of note, however, that upon the characteristics here shown are based the discussions of the properties of the repulsion motor which have occupied so much space in the technical papers.

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FEEDING STEAM BOILERS.

BY R. T. STROHM.

Feed water may be supplied to a boiler in any one of three ways. The simplest method is to use the force of gravity, in which case the source of supply must be above the level of the water in the boiler. Another method is to use an injector, or inspirator, as it is sometimes called. The third method is to use a pump. The requisites of a good feed apparatus are that it shall supply a sufficient quantity of water, as required, and that it shall not fail to operate properly when called upon for service. Capacity and reliability are the main points to be observed in selecting a feeding device.

The simplest gravity feed apparatus is that shown in Fig. 1. It consists of a tank, *A*, supported by saddles attached to the top of the boiler shell. The feed supply pipe, *B*, is fitted with a globe valve, *C*, while the pipe, *D*, and its valve, *E*, give communication between the tank, *A*, and the boiler. The operation of the device is very simple. First, the valves, *E* and *F*, are closed, and the petcock, *G*, opened. Then, on opening the valve, *C*, water flows into the tank, *A*, forcing the air out at *G*, until the tank is almost filled. The valve, *C*, and the cock, *G*, are then closed, and the valve, *F*, opened. Live steam is thus admitted from the boiler to the water. As the pressure in the tank is the same as that in the boiler, the water flows from the former into the latter by the action of gravity, as soon as the valve, *E*, is opened.

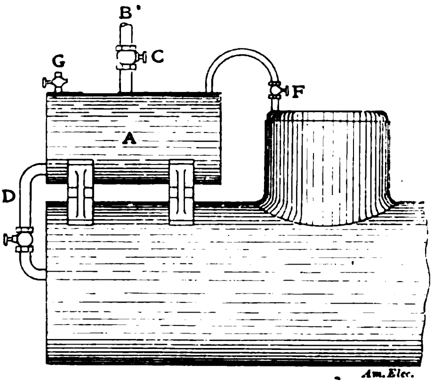

FIG. 1.

While extremely simple in its construction and operation, this form of feed apparatus is out of the question where large quantities of water must be fed. For the valve must be operated by hand, and to accomplish this at proper intervals in large plants would require the undivided attention of one or more attendants. Moreover, the feeding would be spasmodic, and in large quantities at a time, whereas a steady flow of feed water, equal to the rate of evaporation, is desirable from an economical standpoint, as well as from the point of view of the fireman, who aims to maintain a steady working pressure in the boiler. Hence, we find automatic gravity feed apparatus, by which the flow of feed water is fairly constant, the amount being adjusted by hand, to suit the load on the boiler.

One of these automatic systems, illustrated in Fig. 2, makes use of a steam trap through which the water is intermittently discharged into the boiler in small quantities. Fig. 3 shows the construction of the trap. The bowl, *A*, swings on the hollow trunnions, *B* and *C*, and is attached to the counterbalance, *D*. Rigid with the bowl casting is an arm, *E*, which operates the steam valve, *F*. The operation of the system may be understood by reference to both Figs. 2 and 3, in which the same parts are designated by the same letters. The water of condensation enters the bowl, *A*, through the pipe, *J*, and the hollow trunnion, *B*. As soon as the weight of the bowl and the water becomes great enough, it overbalances the weight, *D*, and the bowl sinks downward until it rests upon the frame, *G*. This motion of the bowl causes the arm, *E*, to rise and engage the nuts on the valve stem, opening the valve, *F*. Steam is thus admitted from the boiler through the valve, *F*, into the hollow trunnion, *C*, whence it flows into the upper part of the bowl, *A*, through the curved pipe. This subjects the water in the trap bowl to the same pressure as that carried in the boiler, and as the trap is above the boiler, the water flows out through the trunnion, *B*, into the pipe, *M*, and thence into the boiler. When the water has been discharged the weight, *D*, draws the bowl upward again, closing the valve, *F*, and at the same time opening the small valve beneath *F*. This allows the steam remaining in the trap to be exhausted into the ashpit, reducing the pressure inside the bowl to that of the atmosphere. The water then fills the trap again, and the operation is repeated. The check valves on either side of the inlet, *B*, are simply to prevent egress of water from the boiler while the trap is filling and to prevent the water from flowing back through the pipe, *J*, when the trap is discharging.

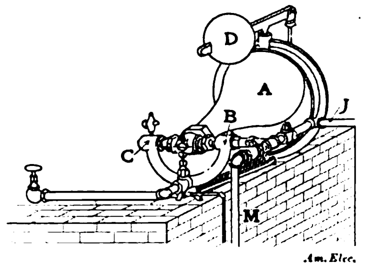

FIG. 2.

It will be seen that this arrangement can be used only when the source of supply is above the level of the steam trap. This is not always an obtainable condition, however, and when it is not practicable, a duplex system may be employed. In this system two traps are used. One of them is placed at a level where the water supply will readily flow into it, and is piped so as to discharge into the second, which is placed above the boiler as in Fig. 2. The lifting of the water is accomplished by the energy in the steam from the boiler. The rate of feeding is regulated by means of a globe valve on the pipe, *M*, which throttles the supply and hence determines the rate of influx.

The injector is an instrument by which the energy of a jet of steam is imparted to a column of water so as to force the latter into the boiler. The injector has always been an object of curiosity to many who fail to understand how a jet of steam at a given pressure taken from a boiler is able to return again to the boiler taking along with it a column of water. The action becomes even more mysterious when steam of a low pressure is used in an injector to force water into a boiler carrying a considerably higher pressure. There is nothing inexplicable or mysterious, however, in the action of the ordinary injector. Fig. 4 shows a vertical cross-section of a well-known make, a description of whose action will serve to make clear the principles upon which all injectors operate.

The inlet, *A*, is for the attachment of the steam pipe leading from the boiler, this pipe being provided with a stop valve, not shown. The water supply pipe is connected at *B* and is likewise furnished with a globe valve. The outlet, *C*, leads to the water space of the boiler, the feed pipe being supplied with a stop valve and a check valve. When about to start the injector, the stop valves in the pipes *B* and *C* are opened, the steam valve in *A* and the check valve in the pipe, *C*, remaining closed. All the chambers and the pipes of the injectors are filled with air at atmospheric pressure. The steam valve in the pipe, *A*, is now opened and the steam, passing through the tube, *F*, leaps the gap and flows into the nozzle, *G*, and thence through the tube, *H*, and out at its lower end, where it backs up in the pipe, *C*, and in the chamber surrounding the lower end of the tube, *H*. For the pressure of this steam is less than the pressure of the steam and water on the boiler side of the check valve, and hence the latter cannot be forced from its seat by this steam current. Consequently, following the line of least resistance, the steam continues to back up in the tube, *H*, finally escaping past the upper end of this tube and flowing through the valve, *E*, into the overflow, *D*, and thence to the atmosphere, since the valve, *E*, is held shut simply by its own weight and the pressure of the atmosphere. This flow of steam from the pipe, *A*, through to the overflow does not last long, however. For as the steam leaps from the tube, *F*, to the tube, *G*, at a high velocity, it draws an increasing amount of air from the chamber surrounding these tubes, and consequently from the pipe, *B*. This drawing along of the air with the

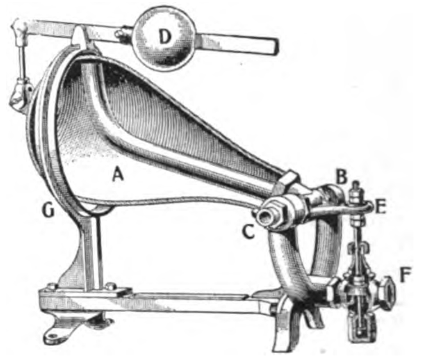

FIG. 3.

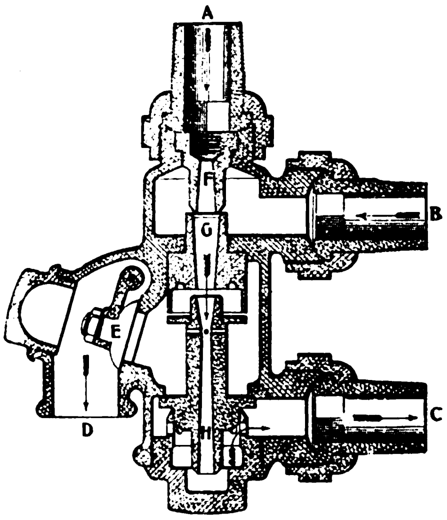

FIG. 4.

steam is due to the fact that a current of any kind, no matter whether it be steam, air, water or any other fluid, has a tendency to induce a movement in the same direction of any medium through which it flows or may come into contact, because of the friction between its particles and such medium. The air being taken out of this chamber, a partial vacuum results, and consequently the pressure of the atmosphere forces water from the supply tank through the pipe, *B*, and into the upper chamber of the injector, until it is filled. Once full, a portion of the water will find its way through the opening between the tubes, *F* and *G*, into the latter, where it will meet and mingle with the steam current. Now, the steam issuing from *F* has a high velocity, and hence possesses a certain definite amount of kinetic energy, or energy of motion. Upon meeting the water in the tube, *G*, it tends to draw the water along with it by reason of the friction set up. This results in largely decreasing the velocity of the steam jet, and at the same time condenses the steam to water, by which process the feed water is heated. The velocity of the jet, while thus considerably reduced, is still sufficiently high to carry the moving column across the space between the tubes *G* and *H*, and thus the current passes from the tube *H* into the pipe, *C*.

As soon as the injector begins to force water from the nozzle, *G*, into the tube, *H*, all escape of steam or water at the overflow, *D*, ceases. At the same time the valve, *E*, closes, due to the pressure of the atmosphere. For, by leaping across the opening between the tubes, *G* and *H*, air is drawn out of the middle chamber in the same manner as out of the upper chamber, and the formation of even a partial vacuum suffices to close the valve, *E*, automatically.

The water continues to be forced into the lower chamber of the injector and the pipe, *C*, until its pressure becomes greater than that inside the boiler. This is by no means impossible. For, on the boiler side of the check valve, there is a column of water under a certain pressure, producing a static pressure on the valve. This water is comparatively still. On the injector side of the check valve there is a column of water moving at a considerable velocity, whose energy is much greater than that opposing it. Hence, the check valve is lifted, and the feed water flows into the boiler, against the pressure of the water contained therein.

The injector thus does work just as certainly as though the steam were allowed to propel the piston of a pump and force the water into the boiler. In either case the energy for the performance of the work is derived from the heat energy of the steam. In the injector this heat energy is changed into kinetic energy by means of free expansion, which takes place in the divergent tube, *F*. The issuing jet is given an extremely high velocity by this expansion, which velocity is afterward transmitted, though much reduced, to the water.

Most injectors are of the class known as lifting injectors, which signifies that they are so constructed as to be able not only to force water into the boiler, but to lift it from a lower level, also. The non-lifting injector does not possess this feature, and consequently it must receive its water supply under pressure from a city main, or from a tank located above the level of the injector. Every injector belongs to either the one or the other of these classes. Aside from the suction of the feed water into the combining chamber, the action of the non-lifting injector does not differ from that of the other class.

Lifting injectors are still further divided into two groups, which are termed automatic and positive. The lifting injector shown in Fig. 4 belongs to the automatic group because, if the flow of water is broken by a sudden concussion, the action will be resumed automatically. They are much used on traction and portable engines for this reason, and doubtless also because of their simplicity of construction as compared with the positive injector. The latter, as commonly found, has two sets of tubes, instead of one. The one set is used to lift the water and deliver it to the second set, the latter then forcing it into the boiler.

Although the injector utilizes about as much steam as would a good pump, it has the advantage of returning all of its exhaust to the boiler without any loss except that due to radiation. Of course, the exhaust from steam pumps may also be utilized in heating the feed water, but not without a larger amount of apparatus, meaning increased cost, space and losses. The injector is a cheap instrument, of little bulk, and of few working parts, which gives the advantage of small and infrequent repair bills.

On the other hand, the injector becomes a most unsatisfactory device if it is not worked under the conditions for which it was designed. In order to operate successfully, the steam pressure must not vary beyond certain limits which are set by the design. The temperature of the feed water entering the injector must not be much more than 100° F., otherwise there will be difficulty in condensing the steam, causing failure to operate, inasmuch as the condensation of the steam is one of the essentials of the action of the injector.

The forms of pumps used for boiler feeding differ somewhat, also. Without doubt the most common is the direct-acting steam pump, in either the single or duplex type. In the former, the valve gear is operated by steam, while in the latter the motion of each piston rod gives motion to the valve for the opposite side of the pump. The direct-acting steam pump is more largely employed for feeding stationary boilers than any other device. In view of the fact that it uses steam full stroke, and is, therefore, not economical as an engine, it must possess certain great advantages which fit it for this purpose.

In the first place, it has no dead centers, and as soon as steam is turned on it starts, provided it is in good condition. It can be made to deliver water at any rate, up to its limit of capacity, by simply throttling the discharge. For the rapidity of movement is proportional to the resistance offered by the water. This makes it easy to adjust the rate of feed water supply to the boiler. Furthermore, the piston has uniform motion throughout its stroke, there being no variation in velocity as in the case of crank-driven plungers.

Fly-wheel pumps make use of the expansive properties of steam, storing up the excess energy in the fly-wheel during the early portion of the stroke, and later giving it up to the plunger. It thus secures an economical use of steam not possessed by the direct-acting pump. However, if it is run very slowly, it may stop on the dead center, from which it cannot start itself. This makes it necessary to control it by throttling the suction, allowing the suction chamber to fill only partly.

The power pump is also used for boiler feeding. It may be attached directly to the shaft of the main engine, or driven by belt, or even operated by a small electric motor. However, if attached to the main engine, either direct or by belt, it can run only when the engine is in operation, which may be disadvantageous at times. Like the fly-wheel pump, it is regulated by the valves on the suction side of the pump.

It will be observed that the method of regulating the direct-acting pump is directly opposed to that used in the case of the power or the fly-wheel pump. The reason must be evident. If the suction of the direct-acting pump were throttled, the water barrel would be but partially filled on the suction stroke. On the discharge stroke, then, the plunger would move some distance against no water resistance whatever, during which time its motion would rapidly accelerate. Upon meeting the water volume filling the remainder of the barrel, the moving parts would be subjected to a heavy shock, which could not but prove detrimental to the pump.

It is very desirable to have at least two independent methods of feeding a boiler, so that, in case either should become inoperative, the other could be used, and thus prevent a complete shutdown of the boiler. Most plants use steam pumps as regular feeders, with injectors as auxiliaries for emergencies.

The point at which the feed water is discharged into the boiler is also a matter of importance. First of all, the incoming current ought not to oppose the natural circulation of the boiler. It should be discharged in or near the coolest portion of the water space, so as not to strike hot plates. It should be diffused, rather than in a single stream. It should also be led through the hot water until it attains about the same temperature as the water already in the boiler before discharging from the feed pipe. This pipe should be easy of access, and ought not to interfere with ingress to the boiler through handholes or manholes.

In view of these requirements, the feed pipe usually enters the front head of a return tubular boiler, near the side, above the upper row of tubes. It is then carried straight back, through the water space, to the rear. Here a short horizontal is attached, by an elbow, carrying the feed to a point directly over the middle rows of tubes. Here another elbow is used, to which is attached a short pipe, extending downward, and perforated throughout the greater portion of its length.

In the case of vertical boilers the feed pipe enters the side of the shell, projecting slightly beyond it, and discharges the feed into the water space just above the level of the lower tube sheet, which forms the crown sheet of the furnace. Water tube boilers usually have the feed water enter the rear of the steam drum, below the water line, where the drum runs longitudinally. In case there are several drums, running parallel to the boiler front, the feed is introduced into the rear upper drum. In one type of water tube boiler there is a mud drum suspended in the hottest portion of the main shell, into which the feed water is led, the idea being to discharge the impurities into the mud drum, from which they are easily removed.

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THE TRAFFIC DESIGN OF CENTRAL OFFICE SWITCHBOARDS.

BY A. DALLAM O'BRIEN.

The design of a switchboard for a telephone central office is naturally divided into two parts: one part relating to the purely electrical features, such as the design of circuits and wiring, and the other having to do with the capacity and type of equipment as dictated by the traffic which it is proposed to handle through the board.

The circuits in use at the present time are practically standard, the only modifications in general use being slight changes in the connecting trunk circuits, which may be made necessary by a difference in ground potential at the several offices in a group. It must not be understood that the statement made above regarding the standard condition of switchboard circuits is intended to apply to all boards, as each manufacturer has his own set of standards and each make of switchboard is a type of its own.

In considering the requirements of a proposed installation from a traffic standpoint, there are a number of important features that must be carefully considered, and a successful design requires most careful study. Where it is proposed to replace an existing switchboard by one of a later type, the problem admits of an easier solution than in the case of installing a board in a hitherto unoccupied territory. In the former case it can be safely assumed that the company has at hand data showing the growth of lines in the territory to be served, the calling rate of these lines, and the distribution of the originating and incoming traffic to the office. From this information a sufficiently accurate prediction of the growth which may be expected in the course of a predetermined period can be made, and knowing the calling rate and traffic distribution the design of a switchboard to satisfy the demands is a comparatively simple matter.

It is the usual practice in switchboard installation to design the equipment so that it may be sufficient to take care of the office growth for a certain period of time, which with most companies is usually about three years. There are a number of reasons why this method is followed. In the first place, in the present stage of telephony, when new ideas and new developments are constantly coming to the front, it is an important question as to just how soon apparatus installed to-day will be out of date; moreover, by equipping a switchboard to last for a longer period of time than three years the telephone company is forced to invest money in equipment which lies idle and pays no return on the investment for a considerable period of time. To provide equipment for a shorter length of time than three years would necessitate frequent additions to the board, and this, as every telephone manager who has had experience will testify, leads to more or less serious impairment of the service and consequent dissatisfaction on the part of the subscribers.

In designing a board to serve a new territory, the engineer must be largely governed by comparisons with similar localities, and the calling rate, classes of service and number of lines to be provided for must be carefully worked out. The first step in a design of this kind is, of course, to thoroughly canvass the territory and obtain as many service contracts as possible. The study of "districting," including the location and number of the central offices necessary to serve a given territory, will not be taken up in this article, as the subject has been very thoroughly covered in recent articles by another author, but it must be understood that a study of this kind is absolutely essential to the successful design of a telephone system. In connection with this study, it is usual to prepare a map of the district showing the location of the central offices and the estimated location and the ultimate number of subscribers' lines which will be served from the group of offices under consideration.

In order to obtain the data upon which to base future switchboard designs, it is the custom of operating companies to make records at stated intervals, showing the condition of the equipment. The peg counts, station and wire report and report of connections constitute the most important of these records. The regular peg count is usually taken at monthly intervals and on a day of the week calculated to give an average record of the incoming and originating traffic, the distribution of both classes and the statement of the number of lines of each class of service that are served by the office and the originating calls per line from each class of lines. This record is taken separately for each of the several offices comprising an exchange district, one record furnishing a check upon the others. The station and wire report is also a monthly record and serves to show the number and class of the connected stations and lines. From successive reports, curves may be plotted showing the growth in the total number of connected lines and also the growth in the lines representing the various classes of service. From a continuation of these curves a fairly reliable estimate of future growth may be obtained and a basis furnished upon which to design future installations. The report of connections is made in conjunction with the peg count, and shows for each office the actual distribution of the incoming and originating traffic, such as the number of calls handled to and from the various points with which connection may be made through the central office considered.

There are three classes of service which must be considered in distributing the lines in a switchboard, these classes representing forms of contracts that are entered into between the telephone company and the subscriber. The flat rate contract allows the subscriber an unlimited number of calls within a specified exchange district; with this class of service it is unnecessary for the operator to make any record of the number of originating calls, except in cases where these calls are for points outside the specified district. The message rate contract provides for a limited number of calls to points within a given exchange district: consequently, it is incumbent upon the operator to keep an accurate record of the number of originating calls from lines of this class. With pay station lines it is always necessary to keep a record of the calls, and in addition, where it is customary to limit a connection to a predetermined time, pay station calls must be timed; thus additional labor is involved on the part of the operator.

The originating calls may be divided into three classes: Local, local trunk and toll calls. The local calls are those which originate for stations connected to the originating exchange. Local trunk calls are those for points within the exchange district and which are reached from the originating exchange by means of local trunks. All other calls are classified under the head of toll business and include all originating calls which are for points outside of the exchange district which are reached either through the medium of a toll board, or in some instances, over direct trunks from the exchange itself.

The connecting trunk lines may also be divided into three classes, comprising circuit, ring-down and common trunks. The circuit trunk as at present employed is terminated in a jack at the sending end and in a cord and plug at the receiving end; in addition, the operator at the sending end is enabled to secure direct connection with the trunk operator at the receiving end by means of a calling circuit. The ring-down trunk is terminated in a jack and drop, or visual signal, at the receiving end and is used for sending calls in one direction only, while the common trunk is equipped with a signal at both ends and is used for sending calls in both directions. The efficiency of the circuit trunk is naturally considerably higher than that of either of the other classes and is therefore generally employed.

There are, however, numerous instances which arise in practice, where the volume of traffic between two offices is not sufficient to warrant the installation of circuit trunks, and it has been customary with some companies to limit the application of the circuit trunk between offices where there is a minimum of fifty calls each way per day, and where the traffic falls below this figure to handle the business by means of a common or ring-down trunk. The number of calls which may be handled by a group of trunks is a direct function of the number of trunks in a group, the efficiency curve being almost a straight line, as shown in Fig. 1. This follows naturally from the fact that where the group of trunks is large the liability of finding all the trunks busy at a given time is small, and each trunk therefore may be worked up to its full capacity.

As an example of the application of the methods used in the design of switchboards, an exchange district consisting of five central offices, one of which is a toll office, will be assumed, and the equipment of one central office of the district be determined. It is assumed that the proper districting study has been made and the office in question found to require an equipment of 1400 lines to last for a period of three years from the date of completion, and, further, that this total be made up of 50 flat lines, 1000 message rate lines and 350 pay station lines. Upon the basis of a calling rate of ten for the flat rate lines and a rate of four for the message rate and pay station lines, the total number of originating calls will equal 5900. Assuming 70 per cent of the calls, or 4130, to be local, and 20 per cent, or 1180, to be local trunk, the remaining 10 per cent, or 590, will be for toll points. The calls which are handled over local trunks will be subdivided into four parts for the remaining four offices of the district, which will be designated *B*, *C*, *D E*, the office under consideration being known as *A*.

If 40 per cent of the trunk calls are for *B* and 20 per cent for each of the remaining three offices, then the sending trunks to *B* will be required to handle 472 calls, and each group of sending trunks to *C*, *D* and *E* will have to handle 236 calls. With these figures at hand, an inspection of Fig. 1 will show the number of trunks required as follows:

SENDING TRUNKS.

Office.	Calls.	Trunks.
B	472	9
C	236	5
D	236	5
E	236	5
	1180	24

The incoming trunked calls from the local offices may be safely figured as being equal to the originating local trunk calls, and the number of incoming trunks required for this traffic will be as shown below:

INCOMING TRUNKS.

Office.	Calls.	Trunks.
B	472	9
C	236	5
D	236	5
E	236	5
	1180	24

Considering the originating and incoming toll calls in the same way, there being 490 calls in each direction, and again consulting the curve, it is evident that there will be required nine sending trunks to the toll board and nine incoming trunks from the toll board.

In the example considered, the traffic between office *A* and each of the other offices in the district is of sufficient magnitude to warrant the use of circuit trunks, and there is consequently no necessity for the installation of either ring-down or common trunks.

From the above calculations, the incoming trunk calls are shown to be 1670, and the total number of incoming trunks required would be 33, the outgoing trunk equipment also necessitating 33 trunks. The number of calls that an operator handling an incoming trunk position can complete in twenty-four hours will vary from 2000 to 3500 calls, depending largely upon the class of trunk equipment employed, such as the use of automatic ringing keys and disconnect signals which greatly facilitate operation. As the total number of calls to be handled over incoming trunks in this instance amounts to 1670, the load is evidently well within the limitations of a single operator, and the equipment of one incoming trunk position is therefore ample to supply the needs of the office.

Before determining upon the equipment of this position, it will be well to determine the number of subscribers' position required to handle the traffic. The number of subscribers' lines that can be apportioned to an operator's position is dependent upon the class of service, the calling rate per line and the number of calls that an operator can handle. Owing to the varying amount of labor required on the part of the operator with calls from different classes of lines, it is necessary to make some assumption based upon experience of the allowable operator's load for the different classes of service. The following loads are representative of usual practice in this regard and are, if anything, somewhat conservative:

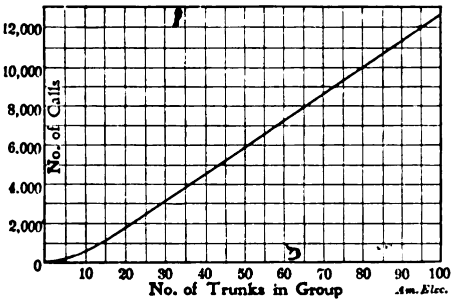

FIG. I.

Class of Line.	Operator's Load.
Flat rate	1600 calls
Message rate	900 calls
Pay station	600 calls

The load of 900 calls, as given above, for message rate service does not consider the use of toll counters, which are automatically operated, either by the subscriber or at the central office, but is based upon the supposition that a check record is made by the operator of each call received. In the example under consideration, the following data have been assumed:

Class of line.	Calling rate.	Number of lines.	Number of calls.	Operators' positions.
Flat rate	10	50	500	.31
Message rate	4	1000	4000	4.44
Pay station	4	350	1400	2.33
Total number of positions				7.08

From this, the number of positions required for the subscribers' operators is found to be 7.08, this result being obtained by dividing the number of originating calls from each class of line by the operator's load for the corresponding class of service. The number of positions having been determined, the distribution of the lines among the different positions must be worked out and the proper number of answering jacks assigned to each position. Dividing the allowable operator's load for a particular class of service by the calling rate per line for that class of service gives the equipment in lines per position, and applying this method to the data previously given, the following results are obtained:

Flat rate lines per position $\frac{1600}{10} = 160$

Message rate lines per position $\frac{900}{4} = 225$

Pay station lines per station $\frac{600}{4} = 150$

The usual subscribers' section consists of three positions and has seven panels, there being 2⅓ panels per position, so that by dividing the above results by 2⅓ the lines per panel are shown to be as follows:

Flat rate	69
Message rate	96
Pay station	68

As the answering jack equipment is usually made up in strips of ten jacks each, the equipment per panel must necessarily be some multiple of ten; thus, equipping the pay station and flat rate panels with 70 lines each, there will be required 400 ÷ 70 = 5 5/7 panels, or say 6 panels. The message rate panels being equipped with 100 answering jacks, each will require 1000 ÷ 100 = 10 panels, making a total of 16 panels. With this data, it is now possible to decide upon the arrangement of the board. In the present instance, by using three-position sections nine positions will be available. The first position will be equipped as an incoming trunk position with 40 trunks, the seven additional trunks being provided to take care of some unforseen demand. The first two panels of the first section will not be equipped with answering jacks, but the remaining five panels of this section and the first panel of the second section will be provided with 70 answering jacks per panel for handling the flat rate and pay station lines; the remaining 13 panels of the second and third sections will be equipped with 100 answering jacks each, it being better to equip the last three panels at the time of installation in order to have a certain amount of capacity above the calculated requirements rather than to run the risk of having to install additional equipment in case the growth of the board should exceed the limits anticipated. Forty outgoing trunks should be multipled throughout the board and each position equipped with a strip of ten calling circuit buttons. As it is a comparatively simple matter to add to the subscribers' multiples, it is only necessary to multiple 1400 lines throughout the board.

The design of the switchboard to last for the period of three years from the date of installation being determined, it is necessary to decide upon the ultimate capacity of the office, or the ultimate number of lines which will be handled through the board.

These results will follow from the districting study previously mentioned. Knowing the ultimate capacity, the ultimate number of switchboard sections can be figured and the space to be occupied by the board determined. From this data, the floor space necessary in the operating room can be decided upon and the location of the present installation so fixed that the board may be capable of additions at either end. As the size of the office increases, the incoming calls will naturally increase, and when more than one trunk operator is required, the first position which was originally equipped as a trunk position may be changed to a subscriber's position by a modification of the keyboard and the addition of answering jacks and two position trunk sections added to the board to take care of the incoming traffic. At the other end of the board, subscribers' sections may be added as necessary.

While only four of the ten circuit buttons installed at the time of opening will be used for trunk calling circuits, several may be required for various instruction circuits, and the remaining buttons will be at hand when the necessity arises for trunks to other points.

In considering the calling rates to be used for the various classes of line in a design of this kind, it is well to use a somewhat higher rate than that shown by experience and by the data obtained. This is due to the fact that as the telephone industry grows, the subscribers become more and more dependent upon the telephone for transacting their business, and as time passes its use becomes more frequent and the calling rate per line rises. The use of party lines may to some extent affect the calling rate, and, consequently, the number of lines which can be handled by an operator; on the other hand, it seems fair to assume that where a party line is used the calling rate per station will be low, and in practice the effect of this class of service does not succeed in raising the calling rate appreciably.

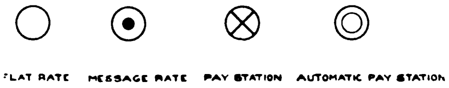

FIG. 2.

Where it is possible to avoid the use of common and ring-down trunks, it is advisable to do so, as the efficiency of these lines falls considerably below that of the circuit trunk, and the labor involved on the part of the trunk operator is also largely increased. It is, of course, necessary that the operator at the switchboard should, upon receiving a call, be able to identify the class of service to which the calling line belongs, and this is usually accomplished by covering the incandescent lamp which serves as a line signal with a small opal cap which is marked with a distinguishing symbol. The symbols which have been used to a large extent by a number of companies are illustrated in Fig. 2, where, it will be noticed, that the flat rate lamp cap is blank. In the case of the board designed herein, it will be noted that one position of a subscribers' section has been equipped with incoming trunks, and that this position being at one end of the section requires the trunk operator to reach across two subscribers' positions in order to have access to the limits of the multiple.

With some types of board this feature may prove objectionable, and in that case it would be well to install in addition to the three subscribers' positions one two-position trunk section and equip the second position of this section with forty trunks. As the two-position trunk sections usually only contain five panels, the multiple being built up higher than in the subscribers' sections, the trunk operator is not forced to reach through so long a distance in order to obtain a connection at the end of the multiple.

There are, of course, a number of special features that always occur in a design of a switchboard for a given case, and these features oftentimes necessitate special treatment. In general, however, the traffic design of a central office switchboard is made along the lines described.

◆

AUTOMATIC BLOCK SIGNALS.

BY RALPH SCOTT.

Track Accessories.

It is evident that wherever a switch occurs, or rails are cross-connected, the ordinary methods of connection would short circuit the track. To prevent this, all cross bars are insulated. Such a form of insulator in shown in Fig. 15 at *G*. To insulate the various sections of track, wood splice bars, which are shown at *H* in the figure, are employed.

The adjacent rails at these splice bars are insulated by means of a fiber rail end as shown at *I*. If the limits of a section occur at a curve, the use of wood splice bars is prohibited, owing to the great strain on the rails at such places. For this purpose special fish plates, insulated by fiber bushings are employed.

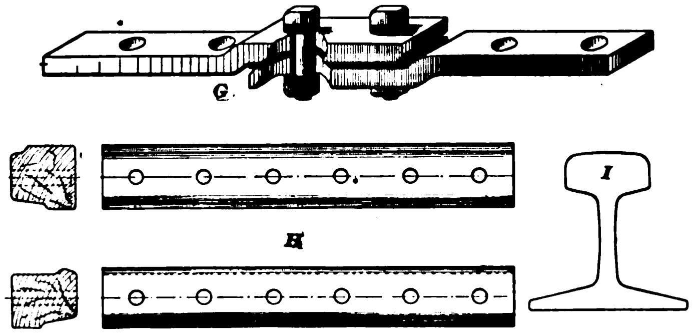

FIG. 15.

The various forms of battery and accessories employed in creating the necessary difference of potential between the rails of a section are shown in Fig. 16. *A* is a Nungesser cell, employing an exciting liquid of saturated caustic soda, with zinc and iron elements, the latter being in the form of a perforated cylinder which is filled with a depolarizer of copper oxide. This cell, on account of its long life, and constancy of operation, with absolute immunity from freezing, is used extensively for railroad crossing signals; but, as yet, has not been introduced to any great extent in automatic signal practice.

The Edison-Lalande cell shown at *B* in this illustration, is of the well-known cast element type, with an electrolyte of strong caustic potash, the elements in this case being of a heavy construction to suit the conditions of long uninterrupted service.

The Gordon cell shown in the illustration at *C* is more largely used than any other for main signal battery purposes; the electrolyte in this cell being caustic soda.

The familiar gravity cell is used almost exclusively for track battery purposes because of its ability to withstand short circuiting for any length of time. The elements which are regarded as the best for signal purposes are shown at *D*, which is the copper, and at *E*, which is the zinc. Both elements when of this form of construction may be cleaned very expeditiously.

The manner of installing track batteries is also shown in this illustration. The iron chute *F*, about 8 feet long, is placed in the ground, from 4 to 5 feet from the track. Connection is made from the rails by wires passing through wooden trunking which are loosely placed in the battery chute and connected to the battery *aa*, which latter are placed in a wooden cage *b*, provided with a rope, by means of which it may be readily removed for cleaning or renewing the battery.

The manner of installing the trunking for connecting the battery wires to the rails is shown in Fig. 17. The trunking *A*, placed about 1 foot under ground, passes to the track connecting wires *E* and *C*, these wires being soldered to insulated copper wires laid in the space within the trunking. A switch instrument is also shown in this illustration, the purpose of which is to short-circuit the track when the switch is open.

The witch point rail rides upon the wedges, *F*, which hold it, therefore, from contact with the rail. The rod, *I*, is not insulated; therefore, when the switch is closed, the track is short-circuited. On account of the uncertainty of this action, the switch instrument *B* also short circuits the track, an end elevation of this instrument and the tie being shown at *G*.

Three forms of battery houses which are in common use are shown in Fig. 18. The battery tank *A*, which is particularly adapted for being installed under ground, is provided with a weatherproof cover, and tiers of shelves, around which the batteries may be arranged, for convenience in inspecting and connecting. The advantage of this type of battery house is that its initial cost is very low, and it eliminates, by its location, all danger of freezing; and excessive evaporation of the liquids in the cells is prevented. The battery house shown in part section and elevation at *B,* and a side view at *C,* is extensively used for locating signal mains. This house is lined with heat insulating materials, shown at *b,* and has its interior provided with rows of shelves *a.* The advantages of this type of battery house are its adaptability to rapid inspection, immunity from being flooded by high water, which is one of the greatest bugbears of railroad signaling, especially during the spring time, or when heavy rains are frequent. Its location above ground also gives free air circulation, and renders it easily portable.

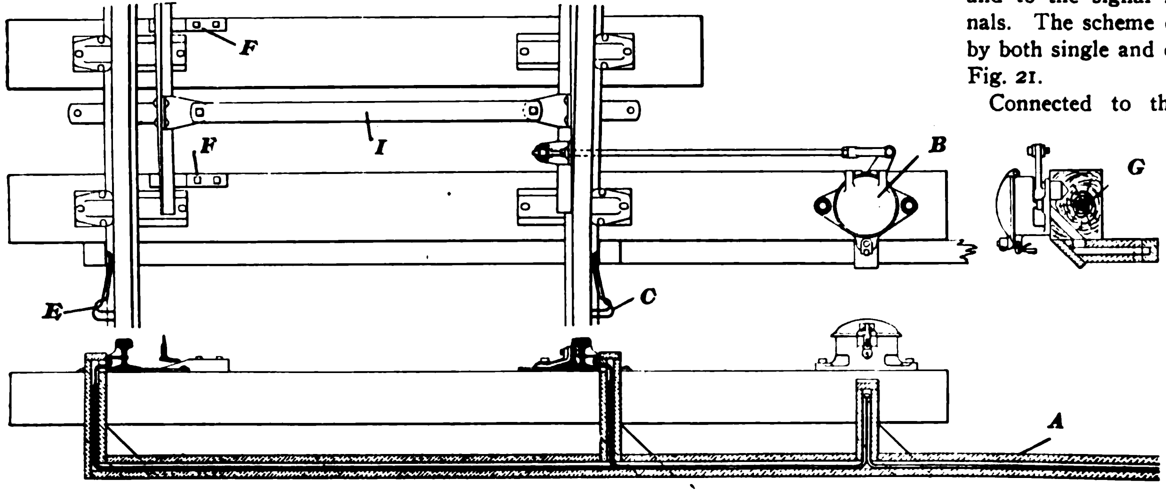

FIG. 17.

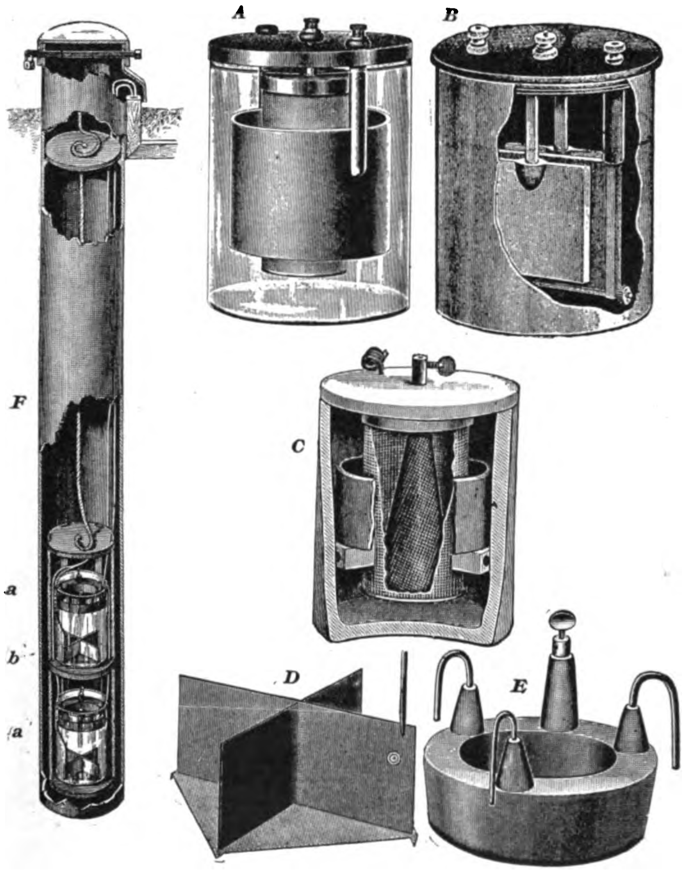

FIG. 16.

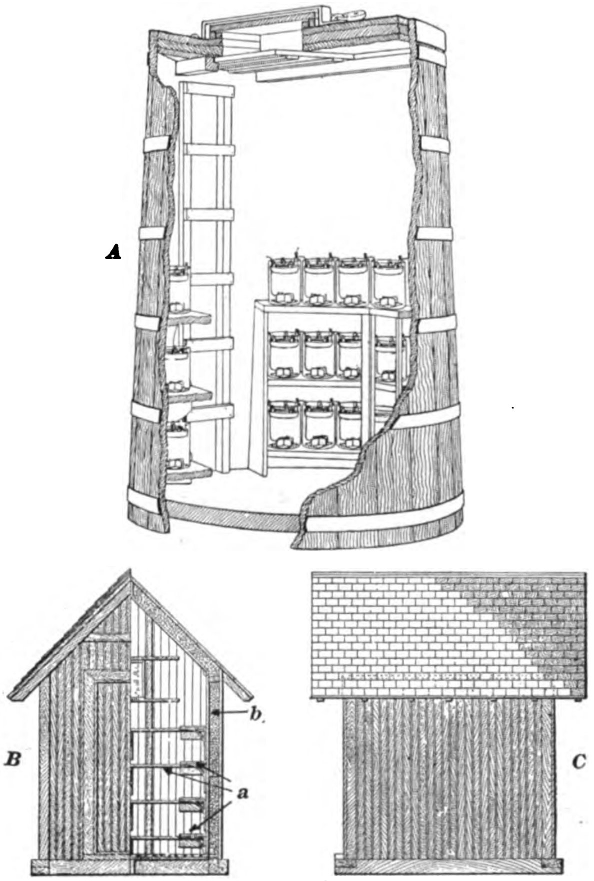

FIG. 18.

Switch Instruments.

The construction of a form of switch instrument which opens the signal circuit is shown in Fig. 19. Upon the wooden base *w,* which is of a width conforming to the number of circuits which are connected to the instruments, is mounted the springy strip *n* in the manner shown.

Riding upon this strip is a small insulated roller *f,* which is carried on the end *m,* of a pivoted lever connected to the point of the switch rail. When the switch is in its proper position the roller forces the end *a* of the spring into contact with the piece *h.* The circuit through the spring is thus closed, one wire being connected to *h* and another to *n.* On opening the switch the action of the roller opens the circuit.

On double track, the switch instrument of a cross-over operates both opposite bound signals. For a home and distant signal, therefore, four sets of contacts are required for each instrument. This is shown diagrammatically in Fig. 20, the wires *a, b, c* and *d* being the home east, home west, distant east and distant west bound circuits, respectively.

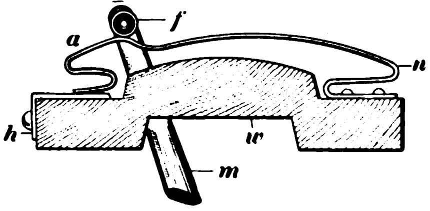

FIG. 19.

With the system employing the method which short circuits the track, it is not necessary to employ line wires passing from and to the signal instrument and the signals. The scheme of connections employed by both single and double track is shown in Fig. 21.

Connected to the single track section shown in the upper part of the figure are the track batteries, *K,* and the relay, *E.* The switch instrument, *B,* which contains two sets (for greater reliability) of contacts, *D,* is connected to the track at the switch, *G.* When the switch is open the track will be short-circuited and thus cause the signal circuit to be opened at the contacts carried on the armature of *E.* To insure certainty of action, the switch point rail, when the switch is in the open position, short-circuits the track.

When the switch is in the normal position, the rail point, by riding on two wedges shown at *L,* and placed on adjacent ties, is kept from contact with the rail, or on any of the wrought iron cross bars or pieces. This renders unnecessary an insulated joint in the switch rail, the cross bond *C* connecting the various rails as shown, insulating joints *N* being placed to render impossible a normal short circuit. If, however, the wheels of a car pass over the siding limiting insulating joints *N*, the signal will be held at danger.

In the lower part of the illustration the connections employed in a double track system at a crossover are shown, the switch instruments *A* and *R* holding, through the action of the armatures on the relays *O* and *S*, the east and westbound signals at danger when the switches are opened.

The arrangement of a switch indicator which will only indicate clear if a train is not within two blocks or sections of it is shown in Fig. 22. This instrument, shown at *i*, receives current from the battery *g*, in series with the two circuit closers *j* and *f*, which are operated by the signals as shown, the other connections of these signals not being given, as they do not effect the operation of this instrument.

The advantages of such an arrangement of connection is that a trainman cannot proceed from a siding to the main line when a train is within two blocks of him. Should *f* fail to open the circuit, it is highly improbable that *j* will not do so. In the lower part of this engraving the arrangement of an indicator *o*, which shows approximately where a train is, is given. The two instruments of this indicator are connected to separate batteries, the circuits of which are controlled by the circuit closers, operated by the movements of the signals *m* and *n* respectively.

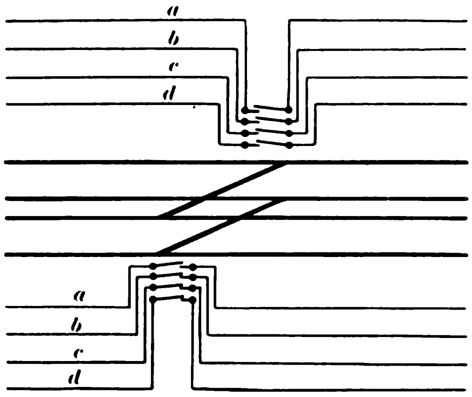

FIG. 20.

The arrangement of a polarized type of switch indicator is shown in Fig. 23. The polarized instrument *c*, placed at the switch *g*, moves according to the polarity of the battery *f*; in series with which is a circuit closer *d*, operated by a relay at this point. The polarity of the current is controlled by the pole changer *h*, operated by a relay at this section. When a train arrives at *d*, the circuit is closed, causing the movable spectacle of *c* to pass before one of the apertures of the instrument. When the train has reached *h*, the polarity of the current passing through *c* is reversed, thus reversing the motion of the spectacle.

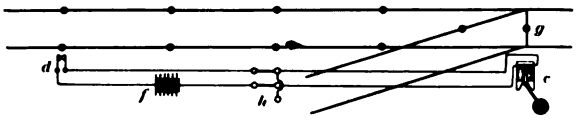

FIG. 23.

A common form of switch instrument is outlined in Fig. 24. This consists essentially of a magnet carrying a movable armature to which a spectacle is attached. This spectacle, moving before the window *h*, provided in the housing placed upon a short wooden plank located at the switch, indicates to a trainman at the switch whether he may proceed from a siding to the main line, or from one main track to another.

Lightning Arresters.

A very important consideration in a signal system, especially if line wires are used, is adequate lightning protection. A common form of arrester used for this purpose is shown in Fig. 25. Upon a porcelain form are mounted the binding posts *A*, *B* and *C*. *A* is connected to the line wire, *C* to the instrument to be protected, and *B* is grounded. The plate *E* is placed a very short distance above the coil of iron wire *D* connected between the binding posts *A* and *C*. When a lightning discharge comes from the line to *A* it will pass around but a few of the turns of *D*, and then jump to the plate *E* across the small intervening air space, and thence to the ground. When a bank of these lightning arresters are connected, the piece *F* on each is used to connect all electrically to the plate *E*, thus rendering necessary but one ground wire. These instruments have proved highly efficient, which is as it should be, since a fused armature contact, brought about by a high potential discharge, is liable to cause a wreck.

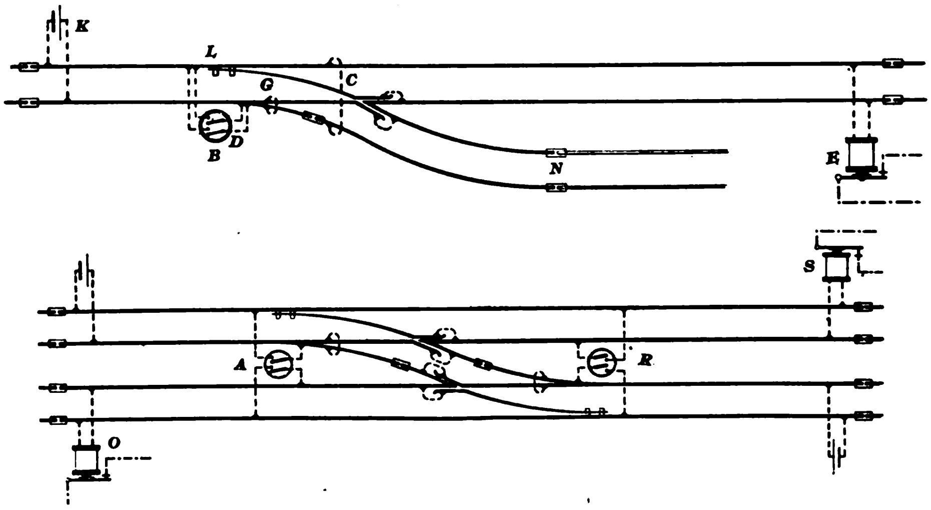

FIG. 21.

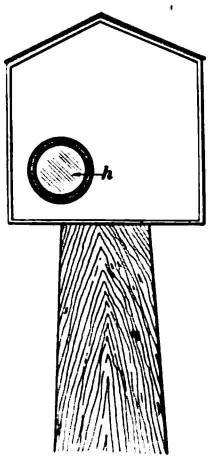

FIG. 24.

Mechanical Signals Automatically Operated

In Fig. 26 is shown a duplex rotary circuit controller and its connections. This circuit controller is secured on the pole of signal *I*, and operated by the rod *M*, which is fastened to the home arm of this signal. This signal is manually operated, and controlled automatically, protecting the track block or section between *J* and *G*. Each signal arm is provided with the electric slots *A* and *C*, which prevent movement of the signal unless everything is in the proper operating condition.

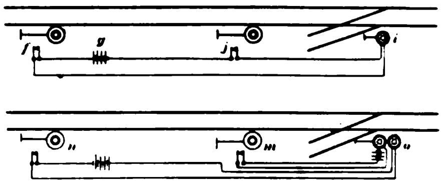

FIG. 22.

These slots are operated by current from the battery *D*, through the contacts of the polarized track relay, *G*. The slot *A* is governed by the neutral armature *F* of the relay *G* and the slot *O* by both polarized and neutral armatures of this relay, and also by the contacts *c* of the circuit controller *E*. The circuit controller, in series with the slot *A*, is operated by the lever controlling the signal arm of *A*. The purpose of this circuit controller is merely to economize in the current consumption, and it is open when the signal arm is in the normal or danger position.

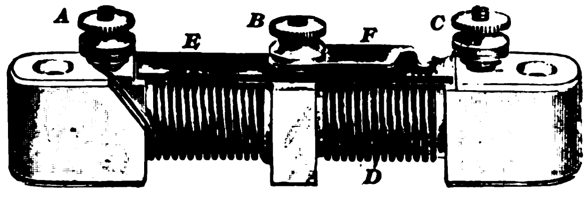

FIG. 25.

When this signal arm is at danger, the contact at *c* is open; therefore the slot *O* is demagnetized, and the arm connected to this slot cannot be cleared until this contact is closed, which action occurs, however, when the home signal arm is moved to the clear position. This distant arm, however, cannot be cleared, if the contacts at *F* and *N* are open, which will be the case if either the track battery *J* is short circuited or has a polarity that holds the polarized contact open.

The pairs of contacts *b* and *a* act in reality as a polarity changer for the track battery *J*, this being effected by the movement of the cam by the rod *M* in a manner which will be evident upon inspection of *E*. The direction of current, therefore, of the rail circuit preceding the signal *I* is reversed with every successive movement of the home signal from clear to danger, or danger to clear. This polarity reversal, by acting upon a polarized relay at the beginning of the track section immediately preceding this signal acts upon the home board and also the distant board of the signal protecting this section.

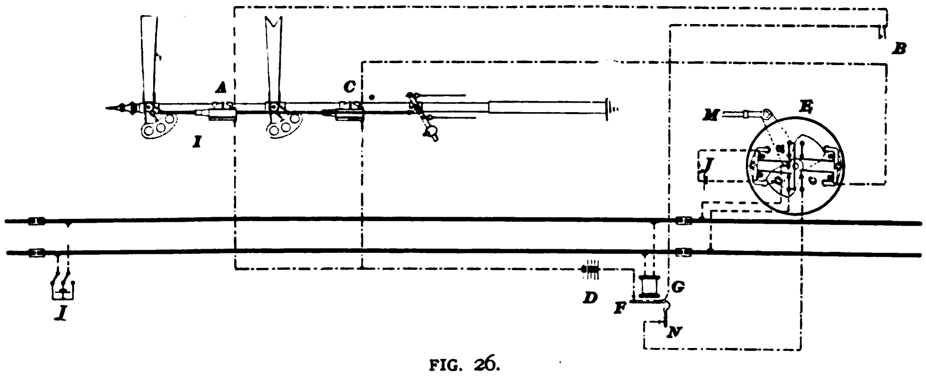

FIG. 26.

The reason for employing cam-shaped pieces in the circuit controller *E* is to prevent any change in the connections until the home signal has entirely completed its stroke, or movement to the full clear position.

Abstracts from Foreign Contemporaries

Single Cylinder Two-Stroke Cycle Gas Engine.—The London *Mechanical Engineer* describes in a recent issue a single-cylinder, two-stroke cycle gas engine devised by B. Brown and F. E. Bowman and illustrated herewith. In this design a scavenging charge is introduced at each revolution to sweep out the spent products of combustion from the explosion chamber, and means are provided for automatically closing the exhaust port as soon as these products are driven out, so as to prevent waste of the mixed air and gas required for the next explosion. The cylinder, *A*, is divided by the piston, *B*, into two chambers, *F* and *G*; the chamber, *F*, being the compression chamber, the charge being drawn into it through a non-return valve, *H*, opening into it by the backward stroke of the piston compressing this charge. Outside this non-return valve a throttle valve and governor are placed by means of which the charge of mixed air and gas is automatically regulated to the requirements of the engine when working under varying loads. Communication between the front, *F*, and the back end, *G*, of the cylinder is provided by means of a passage, *I*, which is opened and closed by the piston itself passing over it when it reciprocates. The piston, *B*, also just before it opens this communication between the front and back part of the cylinder opens on the opposite side of the cylinder a similar port, *J*, through which the spent products of combustion are passed into the atmosphere. This exhaust port, *J*, is so placed that it is fully open before the forward motion of the piston, *B*, opens the port, *I*. The exhaust port, *J*, is not made a continuous opening, but has a grate-like structure, and on the end of the piston, *B*, at the side of which this grating is situated in the cylinder wall at B_1, there is a similar grate or comb, A_1 (see Fig. 2), so that a twist or partial revolution of the piston, *B*, on its axis will cause the comb or grate to close the exhaust port at any time which may be determined before the piston reaches the end of its stroke. To give this axial movement to the piston rod a peg, *K*, is secured to it, which rests in a curved slot formed in a bracket, *L*, secured adjustably to the frame of the engine, so that the reciprocating piston rod, *C*, and piston, *B*, are caused to partially rotate by the peg, *K*, traveling along the curved surface of the slot in the bracket, *L*. On the piston end and opposite to the comb or grate, B_1, which closes the exhaust port, *J*, is a similar projection, *M*, only made solid and not fitting close to the cylinder wall, the object of which is to deflect the incoming mixture of air and gas upward into the far end of the cylinder and thus act more effectually as a scavenging charge. The gas and air may pass from the chamber, *I*, into the cylinder through a grate, as shown in Fig. 2. An electric plug, *N*, is shown at the back of the cylinder for igniting the charge, and water jackets, *O*, are provided surrounding the greater portion of the cylinder. The action of the engine is as follows: On the piston commencing its backward motion the mixture of air and gas is drawn through the induction valve, *H*, into the front of the cylinder, *F*. The forward motion of the piston then compresses this mixture in the front end of the cylinder to a pressure determined by the capacity of the compression chamber. When the piston has moved forward until it opens the exhaust port *J* the spent products of combustion are discharged into the air through the gate *A*, into the exhaust passage *J*, and then the piston still moving forward uncovers the port *I*, communicating with the front end *F* of the cylinder, and the mixed charge under pressure passes into the explosion chamber *G* of the cylinder, and being deflected by the projection *M* on the end of the piston sweeps the contents of the chamber *G* out through the exhaust passage *J*. To regulate or prevent the escape of the mixture of gas and air with the exhaust the gate openings *B*, and *A*, are employed in combination with the peg *K* and curved slot L for imparting an axial movement to the piston, so that before the piston in its backward travel has closed the port *I* it has been moved axially, thereby causing the comb *B*, to close the gate *A*, and exhaust passage *J*, and thus preventing further escape of the compresed gases from the front end *F* of the cylinder. The piston continues its backward motion and further increases the compression in the explosion chamber *G* until the end of the backward stroke is reached, when the compressed charge is fired by the electric ignition plug *N* and the cycle recommences.

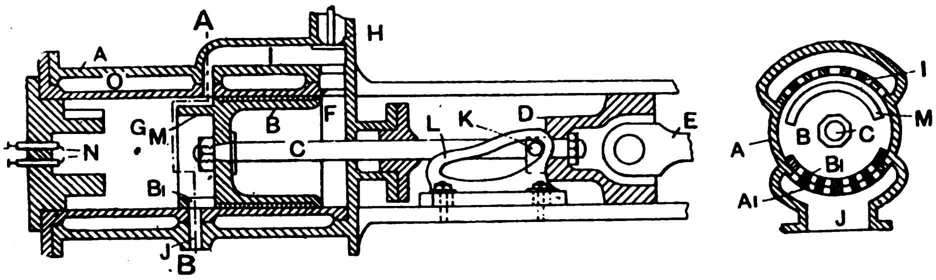

FIG. I.—SINGLE-CYLINDER, TWO-STROKE CYCLE GAS ENGINE.—FIG. 2.

Storage Battery Discharge in Conjunction With a Booster.—While boosters are generally used for charging a storage battery, they are invariably disconnected while the battery discharges and the voltage of the battery is varied by varying the number of cells. This has the disadvantage that the voltage can be regulated only in steps of two volts, and there are always a number of cells which are not fully discharged or not quite as fully as the balance, while there are often cells which are practically never discharged, resulting sometimes in sulphating. *L'Eclairage Electrique* contains an article by M. J. M. G. Doublet, describing the use of a discharging booster during the discharge of the battery, with an improvement in the service of the system. The e.m.f. is regulated by means of the booster, which is kept constantly in service. If the voltage of the battery is too high, the booster acts as a motor, reducing the voltage to the desired amount and driving its motor as a generator. For instance, in order to charge a battery of 300 volts from 220-volt motors, the booster has to give $80 + X$ volts; for this purpose the booster consists of a motor of 220 volts coupled to a generator of $80 + X$ volts. If the battery is discharged through this machine, *i. e.*, if one makes the overvoltage $80 - X$ instead of $80 + X$ volts, the generator becomes a motor and the motor a generator. In varying the excitation either in the generator or in the motor it is possible to vary the discharge current, hence the voltage, as accurately as desired. All cells are then discharged simultaneously to the same degree. During operation of the battery in parallel with a generator, it is possible to regulate the output of each so that the generator always runs with the most favorable load, and as soon as the total load of the station diminishes below this value, the battery is charged again.

Combined Superheater and Steam Generator—The object of the design illustrated by Fig. 3 herewith which forms the subject of a patent recently granted to J. H. Rosenthal, is to provide an independently fired superheater combined in such a way with steam generating elements that the water-circulating and steam-generating water tubes located over the furnace shall, by absorption of part of the fiercest furnace heat, utilize such heat while lowering the temperature of the gases which impinge on the tubes of the superheater, and the water tubes at the ends or sides by presenting a heat-absorbing wall to the action of the fire gases will enable a durable casing to be applied around the superheater without the extensive use of brickwork. Fig. 3 shows a longitudinal section of the superheater. To the right is a front elevation partly in section on line 2—2. Below is a plan partly in section at the line 3—3 and to the right of this is an end elevation of the pressure parts only. The arrangement comprises a skeleton boiler consisting of a steam and water drum, *A*, downcomer tubes, *B*, terminating in cross boxes or manifolds, $C\ C_1$, inclined water-circulating tubes, *D*, connecting cross box, *C*, to a cross box, D_1, into which are expanded tubes, *E*, connected to a cross box, *F*, from which tubes *G* discharge the uprising water and steam into the drum, *A*. The sides of the skeleton boiler are also formed by inclined water tubes, *H*, extending between end headers, *I*, these end headers being nippled into the top and bottom cross boxes, D_1 and *F*, at the rear and in the cross box, *C*, and drum, *A*, in front. The superheater is composed of a series of approximately vertical boxes, *K*, located at one end of the boiler, the boxes being connected alternately to inlet pipes, *L*, into which is led from the various boilers supplying it the steam requiring to be superheated and to outlet pipes, L_1, and having expanded into their inner walls a series of U-shaped superheating tubes, *M*, one limb of each tube being connected to one manifold and the other limb to the adjoining manifold. The superheating tubes, *M*, protrude between the rear uprising water tubes, *E*. The combined superheater and boiler is enclosed in a metal casing, *Q*. The superheater and boiler elements are supported over a furnace chamber, *N*, fitted with a firegrate, *O*, and firing door, *P*. The furnace gases pass up between the rows of water tubes, *D*, and circulates around the superheater tubes, *M*, and escape upward between the steam and water tubes, *G*, to an uptake or chimney, *R*. The fiercest heat of the furnace gases is reduced by their impingement on the rows of tubes, *D*, which absorb part of the heat, and the superheater tubes, *M*, are thus subjected to the action of the gases at a lowered temperature, which increases their durability. We are indebted to the London *Mechanical Engineer* for the above description.

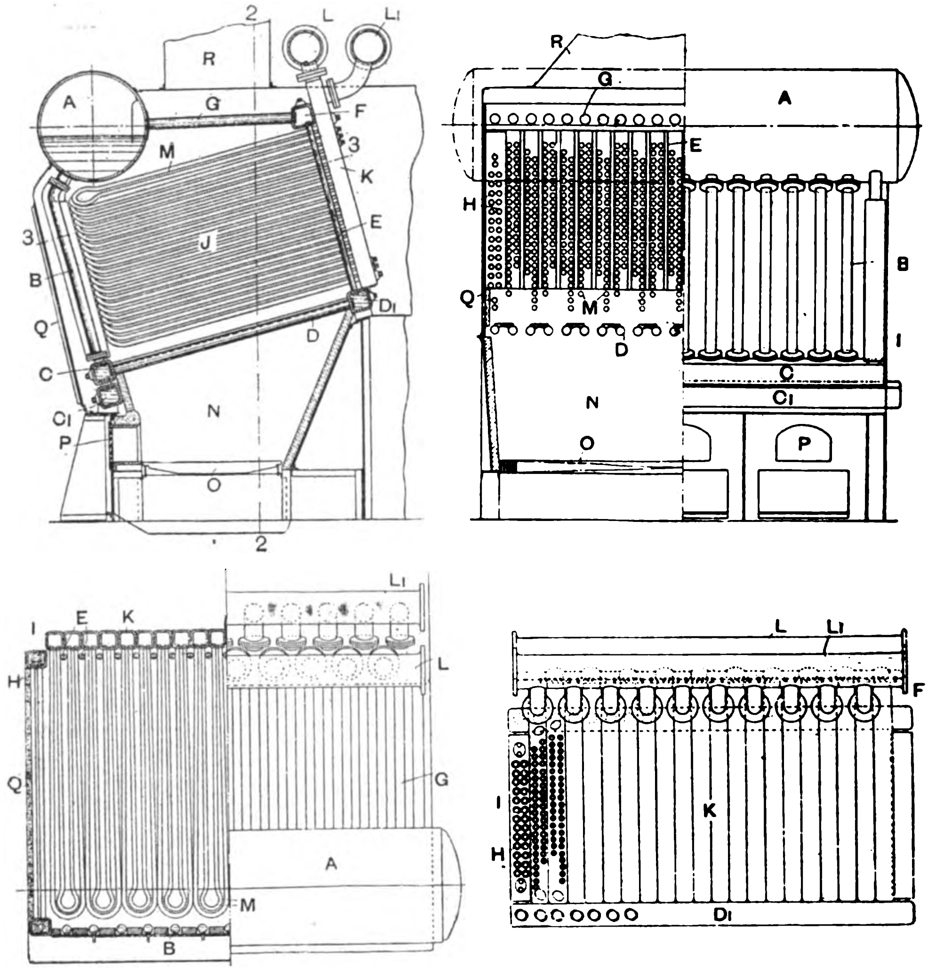

FIG. 3.—COMBINED SUPERHEATER AND WATER-TUBE BOILER.

Suction Producer Gas Engine.—Figs. 4 and 5 herewith taken from a recent issue of the London *Mechanical Engineer* shows a design of gas engine for working in conjuction with suction gas producers. The object of the design is to control the engine so that, notwithstanding great and rapid variation of load, the suction producer is always kept in a sufficiently active state at light loads as to immediately respond to the increased consumption of gas required at heavy loads, and further to provide an attachment to gas engine governors which permits the governor to be arranged for rapidly varying loads or slowly varying loads. The invention consists, broadly, in causing the engine to always draw gas from the producer at least at a minimum rate, this minimum rate being such as will maintain a sufficient incandescent zone in the producer ready to meet sudden increases of load, and also in a governor applied to a suction producer gas engine, which governor cuts off the gas supply to the engine to the lowest point which can be safely done without allowing the producer to cool, and when that point is reached governs the engine, not by further reduction of the supply of gas, but by operating on the igniting device to prevent ignition taking place. The engine thus continues to draw through the producer the minimum amount of air required to keep it in a condition to become fully active instantly when required. Referring to Figs. 4 and 5 there is produced in the air and gas valve casing a bypass *A* leading from the gas passage *C*, so that when the gas valve *D* does not open the engine still draws a certain quantity of gas through *A*, sufficient to maintain adequate incandescence in the producer to enable the latter to instantly respond to a sudden increase of load on the engine. In the bypass *A* a cock *E* is provided, fitted with a handle *F* by which it may be set. The air valve is shown at *G*. The gas valve *D* is controlled by the device shown in Fig. 5, consisting of a step-die-piece, *H*, which operates in conjuction with a pecker *I* and cam to vary the admission of gas during the working stroke of the engine. The die-piece is carried by a rod *J* from one end of a lever, *K*, pivoted at *L*, and operated upon by the governor, which raises the die-piece *H* more or less according to the speed of the engine, the die-piece being stepped as shown in order that the uniform operation of the pecker *I* may impart a correspondingly less or greater lift to the gas valve, the spindle end of which is indicated at *M*. The gas valve casing is arranged by means of a bypass to always allow at least a sufficient amount of gas to be drawn from the producer to maintain adequate incandescence. When the die-piece is removed to a predetermined limit, further governing of the engine, if required, is effected by retarding or cutting out ignition. In Fig. 5 ignition is cut out by an extension of the governor lever or by a lever *N* secured thereto and pivoting about the same pin *L*. The end of the lever *N* carries a pin *O* adapted, when the governor sleeve attains a certain position, to move into contact with one end of a lever *P*, tilt the latter about its pivot, *Q*, and so interrupt the current at the contacts *R S*, the latter of which is fixed, both contacts being in the ignition circuit. Gas is therefore drawn into the engine without ignition occurring.

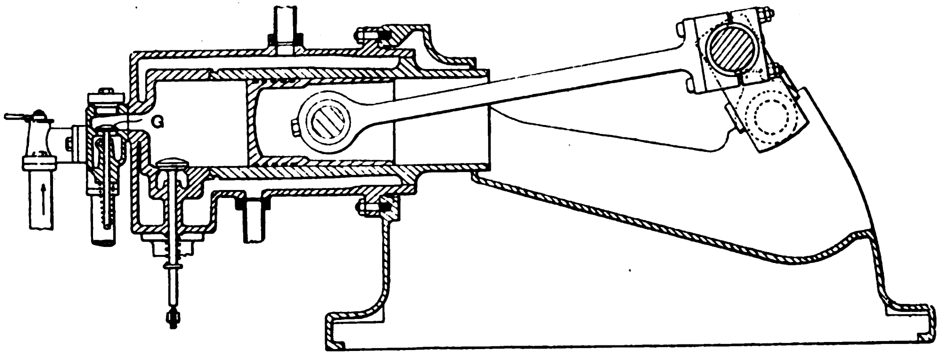

FIG. 4.—SUCTION PRODUCER GAS ENGINE.

Artificial Loads for Electric Generators.—H. C. Davies, in a recent article in the London *Electrical Engineer*, discusses the question of artificial loads for dissipating electric power. An artificial load is an obvious necessity with the comparatively large sets in use at the present day, due regard to liability and freedom from risk necessitating the trial running of the set at something approaching full load for a short time after a repair of anything but a trifling nature has been performed. This is especially the case in alternating works, owing to synchronizing difficulties. In a surprisingly large number of works tubs are used as artificial loads, but they are both impracticable and expensive and in alternating and direct-current works of any size it will be found to pay to install properly designed permanent water loads, the apparatus being simple and inexpensive. The passage of a current through water produces heat; as the boiling point is approached the resistance decreases markedly. For convenient working the water must be constantly renewed in order to maintain its temperature. The nature and supply of the water must also be considered, as the resistance is apt to vary greatly. While the water load is undoubtedly the best and handiest medium for testing, there are other types in use which may be recommended for purposes apart from machine testing. The carbon rheostat was one of the first power absorbers and has done excellent service. The best form is made up of a series of carbon plates in a frame fitted with a screw for tightening up or slackening back, the contact between the plates being increased or diminished and the resistance of the whole varied in proportion. In this form the resistance is due not so much to that of the carbon itself as to the more or less bad contact between the plates. Cooling is the chief difficulty presented by this apparatus and for this reason it is more suitable for small powers than for large. A handy, inexpensive form of artificial load may be made up of galvanized-iron netting wound in a spiral, using non-inflammable insulating distance pieces, or by folding backward and forward over an iron frame built up on insulators. This is valuable for testing small machines such as exciters. Iron netting, especially that having a right-angled mesh, is an excellent dissipator of heat, one set of wires carrying current, while the other, at right angles, conducts away much of the heat. Expanded metal also makes an effective resistance and in many ways is preferable to netting, being stronger and requiring less supports.

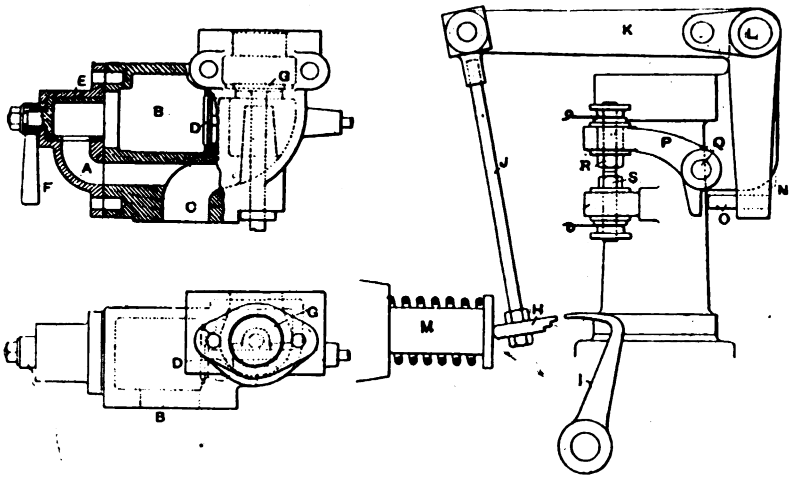

FIG. 5.—DETAILS OF SUCTION PRODUCER GAS ENGINE.

The Standardization of Electrical Machinery.—London *Engineering* contains the interim report of the sub-committee of the Engineering Standards Committee on generators, motors and transformers, dealing with the principal conditions with which it is desirable that these articles should conform. The committee determined not to risk hampering the trade with standard dimensions and shapes which might easily become obsolete as designs improved, but confined themselves to the more immediate necessity of securing uniformity in pressures and frequencies, rating of plant and conditions of test. The standard voltages recommended are as follows:

Alternating or direct-current, at the terminals of the consumer	110, 220, 440 and 500 volts
Alternating current at the generating terminal	2200, 3300, 6600 and 11,000 volts
Standard pressure at primary terminals of alternating-current transformers	2000, 3000, 6000 and 11,000 volts
Standard pressure at secondary terminals of alternating-current transformers	115, 230, 460 and 535 volts at no load
Standard pressure at teminals of direct-current traction motors	500 volts

A variation of 10 per cent. either way is permitted in the above figures, so that plants built to the standards recommended may be employed on the great majority of the existing systems, although it is hoped that in course of time such latitude will become unnecessary. For alternating current a frequency of 50 periods per second is to be adopted as the standard, although in special cases, where a lower frequency is advisable, a secondard standard of 25 cycles is allowed. The difficulties in connection with the rating of generators and motors have been met by dividing the machines into two classes, according as they work continuously or intermittently. Machines of the former class must be capable of giving the rated output continuously for six hours, and the latter for one hour. When not otherwise specified, continuous working is always to be understood, and every machine is to bear a name-plate giving such particulars of the output, voltage, frequency, revolutions per minute, exciting current and power factor, as bear upon its particular type. The output of generators is to be measured in kilowatts, and that of motors in brake horse-power. Direct-current generators are in future to be made in six standard sizes—from 6 to 100 kilowatts, inclusive—and a suitable speed has been recommended for each size. From 100 to 1000 kilowatts, inclusive—there are nine sizes—machines up to 250 kilowatts having two alternative standard speeds, while above this size an additional slow speed is added, making three speeds in all. Alternating-current generators are required to give a sine wave as nearly as possible under all conditions. The field excitation for simple alternators should be at either 65, 110 or 220 volts. The variation of pressure at the terminals between full load and open circuit under the same conditions of speed and excitation must not exceed 6 per cent of the normal on a non-inductive load, or 20 per cent on a load with a power factor of 0.8. Motors are classified as open, protected, ventilated or totally enclosed, a "protected" motor being one in which the interior is shielded from accidental contact without interfering with the ventilation; and a "ventilated" motor, one in which, although ventilated, access to the interior is only possible by opening or removing the casing. Direct-current motors are standardized in 15 sizes, from ¼ to 100 brake horse-power, inclusive; single-phase motors in 11 sizes, from 1 to 25 brake horse-power, and two and three-phase motors in 17 sizes, from 1 to 100 brake horse-power. The speeds at full load are given for every size; and in the cases of alternating-current motors the figures are the synchronous speeds at no load, and a reduction of speed from 7½ per cent in the smaller sizes to 2½ per cent in the larger at full load must be allowed for. In connection with the work of the committee, experiments are being carried out at the National Physical Laboratory to determine the safe temperature rise allowable in the coils of dynamos and transformers. The results are not quite ready for publication, although the report indicates that they will be of considerable value, and will result in the recommendation of higher temperatures than have been advised by either the German or American standardization committees. Meanwhile, it is of interest to note that the temperature of the hottest part of a coil, as determined by measurements with a thermo-couple, never exceeds the mean temperature of the coil, by more than 25° C.

SOME RECENT ELECTRICAL PATENTS

Securing Armature Coils.—For several years past, many builders of dynamo-electric machinery have used strips of insulating material driven into grooves in the armature teeth just below the tooth-heads to hold the armature coils in the slots of slotted cores; these strips have heretofore extended the full length of the coil slots and projected slightly at each end of the core, covering the embedded part of the winding completely. The grooves in the sides of the teeth reduce the cross-section of the magnetic path at that point, of course, so that in some cases the teeth are more highly saturated than at the roots. In order to obviate this disadvantage, Isaac De Kaiser proposes the arrangement shown in the accompanying illustration and has secured a patent on it. It consists merely of short retaining strips, 7, in short grooves, 6, one at each end of each coil slot, instead of a long strip throughout the whole length of each slot. The core discs between the inner ends of the retaining strips are not grooved; the restriction of the magnetic path on account of the retaining strips, therefore, is confined to a few teeth at each end of the core. Although the inventor does not mention it in his specification, the better ventilation obtained by this arrangement as compared with long strips covering all of the embedded part of the winding is probably a greater advantage than the one claimed. Patent No. 756,228.

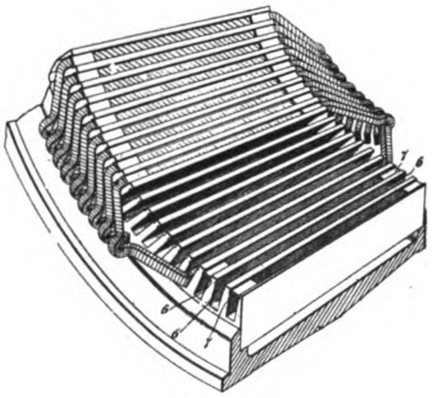

FIG. 1.—ARRANGEMENT FOR SECURING ARMATURE COILS.

Telephone Receiver.—Fig. 2 illustrates a form of telephone receiver invented and patented by Ernst Gundlach, the object being to increase the effectiveness as compared with a receiver of ordinary construction embodying the same quality of materials. The fundamental feature of the invention is the application of spring pressure to the rear face of the diaphragm, this being said to increase the speaking efficiency of the instrument. The diaphragm is pressed away from the magnet by means of a dished metal disc, *C*, a plan view of which is given by Fig. 3. To the center of the diaphragm is attached a soft iron plug, *b*, which projects into the bore of the magnetizing coil and is almost in contact with the stationary soft iron core, *v*, attached to the permanent magnet, *D*. The latter is supported by a circular cup, *E*, held in place by the receiver cap along with the diaphragm. The tension disc, *C*, presses against the diaphragm about half way between the center and the periphery. Patent No. 762,820.

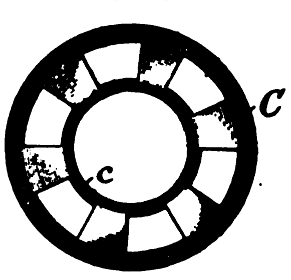

FIG. 3.—PLAN OF METAL DISC.

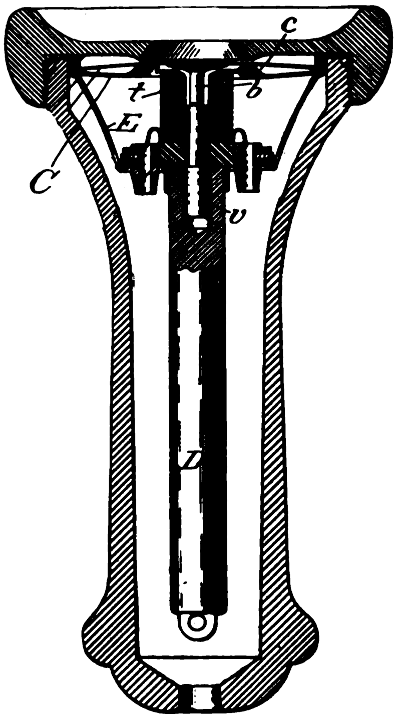

FIG. 2.—SECTION OF TELEPHONE RECEIVER.

Gasoline Motor Car Design.

To the Editor American Electrician:

I wish to bring to your attention an error in the drawings for an automobile in the July number of The American Electrician. In the detail drawing of the brake-shoe, Fig. 26, on page 253, the hole for the pin which attaches it to the brake pedal is at right angles to the position it should occupy. This will be readily seen by reference to the plan view of the chassis on page 349. Of course, the lug which carries the hole would also have to be turned around; this would involve a slight change in the shape of the casting. Probably others among your many subscribers have already noticed it, but I thought I would mention it as a brake-shoe made according to the detail drawing would be absolutely useless.

Dorchester, Mass. H. K. Spencer.

[It is not intended that the brake-shoe shall be pinned directly to the brake pedal. A link is intended to be used to connect the two, the holes in the ends of the link being drilled at right angles to each other: unfortunately, this was omitted in the description and drawings.—Editor.]

Single-Phase Wattmeter Construction.

To the Editor American Electrician:

In the August issue of the AMERICAN ELECTRICIAN the "Abstracts from Foreign Contemporaries" contains an item with the heading, "Single-Phase Wattmeter," taken from *L'Industrie Electrique*. With reference to the motor system described in this item, I beg to say that as far as the shunt or potential circuit is concerned, it embodies the same principles that have been used for a number of years in induction wattmeters built by the Stanley Instrument Company. This method of phase adjustment is covered by United States patent No. 658,815, issued to William Stanley, which describes a means for lagging the current in the potential circuit by means of the shunted magnetic circuit or magnetic bridge. This same scheme of a magnetic shunt or magnetic bridge is shown in the sketch, Fig. 16, in the item above mentioned.

E. W. GOUGH,
Stanley Instrument Company,
Great Barrington, Mass.

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NOTES.

The Association of Edison Illuminating Companies will hold its twenty-fifth annual meeting at the Hotel Wentworth, New Castle, N. H., beginning Tuesday, August 30. A number of extremely interesting and valuable papers are promised.

Power is the title of a handsome booklet issued by the South Bend (Ind.) Electric Company and containing a strong argument for electric power. Progressive central station men will find the book at least interesting and perhaps valuable as a suggestion for similar things from their own standpoints.

The Telautograph for Office Work.—The Prudential Insurance Company has installed a telautograph system as a means of communication between its cashier's office and policy loan department. Presumably, the use of this class of apparatus was chosen in order to have records of instructions without the risk of inaccuracy involved by having typewritten records made after instructions had been transmitted verbally; otherwise an interior telephone system would appear preferable.

Combined Central Station and Municipal Plant.—At Wausau, Wis., the perennial question of municipal ownership *vs.* central stations has been solved in a manner which appears to be well worthy of consideration in other localities. The city is going to install, maintain and handle the distribution system and street lamps, buying current from the central station company which, presumably, will be allowed to install a distribution system for private service. The lamps are to be 420-watt alternating enclosed arcs, taking 6.6 amperes and operated in series.

Special N. E. L. A. Train to St. Louis.—The National Electric Light Association has decided not to hold a convention at St. Louis during the Exposition period, but arrangements have been made for a special train from New York for association members who wish to attend the International Electrical Congress. This train will leave the Grand Central Station, New York, at 1 p. m., September 10. Full particulars may be had from Mr. Alex. Henderson, 527 West Thirty-fourth Street, or Mr. George F. Porter, care National Electric Light Association, 136 Liberty Street, this city.

Lectures at the New York Trade School.—Following the usual custom, a series of evening lectures on steam and electrical engineering will be given during the coming fall and winter at the New York Trade School, First Avenue, Sixty-seventh and Sixty-eighth Streets. These lectures are intended for practical workers, stationary engineers, firemen, electrical workers and machinists. They represent an attempt to supply the need for practical information, and explanations of phenomena and experiences in daily work. The lectures take more of the nature of a conversation between the lecturer and his hearers, and questions are freely asked and explanations given, accompanied by illustrations and, where possible, by experiments. The main object of this course is to present in a simple and easy way, to men of practical experience, the reasons for the laws upon which their work is based, and explanations of the phenomena that have led to the formulation of these laws. The cost of attending each of the courses on Steam and Electricity is one dollar. Information as to dates and arrangements can be had upon application to H. V. Brill, superintendent, New York Trade School, Sixty-seventh Street and First Avenue, New York.

Trial of the Arnold Single-Phase Railway System.—On August 3 an interesting test of the Arnold electro-pneumatic railway system was made on the tracks of the Michigan Suburban Railway Company, at Lansing, Mich. In this system, a single-phase motor is used, the armature of which is always in motion. In starting, stopping or at any speed short of that corresponding to the synchronous speed of the motor, the field also revolves and drives, or is driven, by a compressed air engine. In the former case energy is stored as compressed air in a tank, and in the latter case is given out. By this means not only can a car be operated at any speed by the employment of single-phase current, but a constant load is kept on the power house.

The trial was made with the car equipment which was partly destroyed last winter in a fire which burned down the car barn where it was stored, the fire occurring a few days prior to the date set for a trial of the system. The machinery had been partly repaired, but owing to cracked castings a complete demonstration was not possible on the trial. The object was to determine, as far as the damaged apparatus would permit, the control of the system and the taking of current from the trolley at 6,000 volts. The car at times attained a speed of 25 miles per hour, and no difficulty at all was experienced even at this speed in taking current from the trolley. Mr. B. J. Arnold, the inventor of the system, who was present at the trial, expressed himself entirely satisfied with the control which enabled speeds from the lowest to synchronism to be maintained and was very satisfactory in retarding and accelerating.

The Temperature of Boiling Water.—No doubt everyone who has occasion to use the ordinary Fahrenheit thermometer to any serious extent has at one time or another asked himself why the boiling point of water is marked 212°; and at first sight it does seem a somewhat stupid number to use as compared with the round 100° adopted on the scale of the Centigrade instrument used in France. Like many other apparently stupid things, however, the 212° had its origin in a desire for simplicity and permanence, and has become stranded on the rocks of inconvenience as a result of the world's wider knowledge, and aptly illustrates the danger of setting limits to its range. Fahrenheit, who first introduced the thermometer which bears his name, was familiar with the effect of a mixture of powdered ice and salt, which was then regarded as the very ultimate limit of cold obtainable, and made this his zero, in the expectation that it would serve for all time. Seeking for some fixed and equally convenient point which should serve as his upper datum, he fixed on the temperature of human blood as a point which remains unvarying for all generations, and made this his 100° mark (though it was subsequently found that his measurement of this point was slightly inaccurate, blood temperature being about 98½°). This scale of graduations, it will be evident, was from Fahrenheit's point of view and limited knowledge quite as rational, in fact identical in principle, with that adopted by Celsius for the Centigrade thermometer. Continuing the graduations upward beyond Fahrenheit's 100° or blood temperature mark, it became purely a matter of registration that the temperature of boiling water was 212°. The primary range, viz., that between the temperature of an ice and salt mixture and human blood, was 100°, and Fahrenheit's mistake lay in assuming that his zero was the absolute one. The Centigrade scale, with the freezing and boiling points of water as the upper and lower limits, certainly seems more rational for most ordinary temperature measurements, but the average person is apt to forget that it is only conventional, and that for purposes of exact measurement the physicist must refer his phenomena to the absolute zero, where temperature ceases to exist, where hot and cold have no meaning, and every form of matter is devoid of motion and is utterly dead. This is the only real zero of temperature.—*Vulcan.*

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Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

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The American Electrician has a larger paid subscription list than any other electrical journal in the world.

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The New Single-Phase Railway System.

Elsewhere in this number will be found a brief description of a single-phase railway equipment which cannot fail to be of vital interest to all concerned in electric traction. Like many other highly important developments, the new motor is remarkable chiefly for its simplicity and conformity to well-recognized principles. The bugaboo of armature reaction is disposed of by the familiar expedient, adopted by Prof. Ryan in direct-current work, of practically surrounding the armature by distributed stationary windings having a magnetomotive force more than sufficient to neutralize that of the armature winding. The main field winding is also distributed, so that the field magnet structure is very similar to that of an ordinary induction motor. The armature is in all visible respects similar to that of a direct-current motor. This, of course, is not the whole story; while the machine is very simple as a net physical result, its successful design must have involved tedious and most painstaking investigation and analysis in order to attain satisfactory compromises between opposing factors.

The plan of exciting the "compensating" winding by means of the main or working current—connecting the winding in series with the armature—instead of by means of induced currents, confers the inestimable advantage of dual operation; the motor works just as well on direct current as on alternating—or even better—and by means of a suitable transformer a car can be operated on any alternating trolley voltage. Cutting out the transformer and putting the field windings all in series leaves the car equipment ready for work on any standard direct-current trolley line. This feature disposes of one of the most serious, if, indeed, not the chief, objection hitherto urged against alternating-current traction in this country. With a "universal" car equipment, operating companies are in position to retain their direct-current systems for congested centers and to use high-voltage alternating current for outlying districts, long interurban links, etc.

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Joint Steet Lighting Plants.

In another column will be found an interesting item of news to the effect that in Wausau, Wis., it has been decided to try joint ownership and maintenance as a solution of the vexatious problem of street lighting economics. The company owning the central station is to operate it and supply curent to the arc-light circuits at so much per kilowatt-hour; the city is to own the pole lines and lamps and keep them in operative condition, just as the owner of a printing office or other industrial establishment does with regard to his motor or motors. This arrangement appeals to one strongly on first consideration. There will, of course, develop sources of contention, but we can think of none which cannot be disposed of efficiently and permanently, provided neither side is abnormally stubborn and unreasonable. Many of the widely experienced central station managers have long held the opinion that the maximum of satisfaction to both the company and the consumer is obtainable with the minimum of friction and worry when the company rigidly restricts its commercial activity to the supply of current, exercising, of course, reasonable supervision over the customer's policy in the matter of selecting his lamps, motors or other apparatus, in order that dissatisfaction may not arise from grossly inefficient translating devices.

Considered in the abstract, there is really no reason why a municipality should not bear the same relation to the operating company that the smaller consumers bear. A lighting circuit and complement of lamps is at least of as much value to the city as to the company, and the municipal ownership of the complete street outfit should very largely simplify the relations between the two interests. Most towns of any importance have their own fire departments, and the care and maintenance of the street lighting circuits might be combined with the same attention to the alarm circuits and apparatus with considerable advantage in both directions. A somewhat higher grade of technical skill is required for the repair of arc lamps than for the maintenance of electric bells, batteries, etc., and the same is true of arc lighting and fire-alarm circuits, respectively. Given a staff of employes competent to keep the lighting system in good condition, therefore, the fire-alarm system would in all probability receive more effective care than it usually does now. Moreover, much work would be feasible in the local repair room that is now sent out and done at relatively high cost. The combined supervision of the two systems, however, is by no means the limit of advantage derivable from the municipal ownership of the street lighting equipment; the many other possible benefits will readily be apparent to those who have had experience with obstreperous city councils.

The Passenger Elevator.

Within the past few months there has been an unusually large amount of discussion of hydraulic *vs.* electric power for operating passenger elevators, and some rather labored arguments have been offered in several instances to show the great superiority of the hydraulic system. The chief weakness in most of the arguments lies in comparing the ideal hydraulic system with the actual electric system; bringing out strongly the inherent advantages which ought to be realized by the use of water and setting these up against the well-recognized practical shortcomings of electrical systems as developed in every-day service. It seems to us that advocates of the hydraulic elevator would make out a much stronger case if they were less partisan; certainly those who are at all familiar, not with the constructional details but with the actual results obtained in practice, would be more favorably influenced by the claims made for the hydraulic system if those claims were less prejudiced and agreed more closely with one's observation.

The hydraulic elevator has several advantages which are realized in practice. The chief advantages are: (1) The prime mover has a reciprocating motion corresponding with that of the car, so that acceleration to a high speed is obtainable with less complexity and greater smoothness of operation; (2) the operating medium is inelastic, rendering braking unnecessary and thereby decreasing the risk of accidentally dropping the car; (3) overloading the car before trying to start from the bottom of its travel cannot damage the system nor cause delay by the operation of safety devices. The chief disadvantages are: (1) Serious inefficiency, the same quantity of water being required to lift the empty car that is used to lift the maximum load; the car cannot be over counterbalanced, which also lowers the efficiency; (2) the apparatus occupies very much more valuable space than that of the electrical system; (3) when repairs to the elevating mechanism proper are necessary, they are more difficult to make, being usually of a character requiring the application of considerable physical strength in very close quarters.

The principal advantages of the ordinary forms of electrically operated elevator are: (1) Very high all-day efficiency due to the facts that the power taken by the motor is roughly proportional to the total load and that the car is over counterbalanced about 50 per cent.; (2) the apparatus is all concentrated near the elevator shaft, rendering the location of trouble easy; (3) parts damaged by accident may be replaced with great facility. The disadvantages of importance are the delicacy of the control mechanism and the absence of the advantages noted for the hydraulic system.

It is frequently claimed that the hydraulic system is more rugged and therefore requires less repairs than its electrical rival; this is undoubtedly true of the control mechanism alone, but not necessarily true of the main apparatus. We have observed many instances of hydraulic installation one part or another of which was in trouble most of the time; one of these consisted of a bank of five elevators, of which one-fifth was out of commission more than 30 per cent of one year. The claim is also made now and then that the hydraulic machine is safer because it has inherently positive travel limits: the piston cannot travel more than its full stroke. It does not require vivid imagination to predict what would happen if the valve became jammed wide open upon starting the car from the bottom of the shaft; the "positive limit" of travel at the piston would not make the occupants of the car more comfortable after the latter arrived at the top of the shaft.

There is no question that each system has its legitimate field of operation in which it is distinctly superior to its rival, so that broad claims of greater advantages for either of them are absurd. We are firmly convinced, however, that the full possibilities of the electric elevator have by no means been utilized. That it is not, or cannot be, adapted for high-speed work we refuse to believe, and there seems to be no insuperable obstacle to its successful competition with water power in this field. The development of the hydraulic elevator appears to have reached it ultimate limit, if one might be so rash as to say that of any branch of engineering; the electrically operated system, however, should certainly be capable of better things than have thus far been demonstrated.

Frequency and the Induction Motor.

It is often stated, without the proper qualification, that the cost of building a high-frequency induction motor is lower than that of a machine built for a lower frequency. This is universally true of a transformer, but in the case of the induction motor the question of speed modifies the foregoing statement importantly. If the number of poles remains the same, then a high-frequency motor costs less than one for lower frequency; the fact that the speed is directly proportional to the frequency, combined with the knowledge that high-speed machines of any type cost less than those operating at low speed, is sufficient explanation of the relation between costs with the same number of poles. But it is almost generally overlooked, except by designers, that for the same number of revolutions per minute, an induction motor of given output and frequency costs more money than one of the same output and a lower frequency. This is because a greater number of poles is required at the higher frequency, which necessitates a larger diameter of machine. Another point ordinarily overlooked is that high-frequency machines necessarily have lower power factors than those built for lower frequencies. Taking into consideration the requirements of central station work and the foregoing facts, it would seem that 35 or 40 cycles is preferable to any higher figure for general service plants. Lower frequencies render illumination by incandescent lamps unsatisfactory and even dangerous to the eyes.

Sources of Electrical Fires.

A letter from one of our readers, which is published this month, contains suggestions as to the actual causes of electrical fires which are well worthy of concentrated thought. A perusal of the last quarterly report of the National Underwriters' Electrical Bureau will show that a large proportion of the fires caused by electricity during the three months covered by the report was due to crosses, disarrangements of circuits and similar abnormal conditions against which no set of construction rules can effectually provide unless they be made so stringent as to work unnecessary hardship upon most manufacturers and contractors. The personal element is so important and widely variable a factor that a code of rules adequate, even by rigid enforcement, to protect against the multitudinous vagaries of human nature would probably rival the Encyclopædia Britannica in bulk. The moral of this brief homily is that until human beings become absolutely conscientious and infallible, electricity, like all other forces and powerful agents, will continue to be a source of danger to a highly unnecessary extent.

HOW TO MAKE A HIGH-VOLTAGE TESTING BATTERY.

BY GEORGE T. HANCHETT.

In testing insulation a common method is to measure it directly by means of a Wheatstone bridge and a few batteries. Those who have had practical experience with such test know that the results are practically worthless because the insulation is not subject to an electric pressure at all commensurate with that which it will have to stand in practice, and, furthermore, insulation resistance is by no means a constant quantity, but is a very irregular function of the pressure. At 2 volts it may be several megohms, at 100 volts perhaps a megohm, at 500 volts only 500,000 ohms, and at 1000 volts a short-circuit may develop.

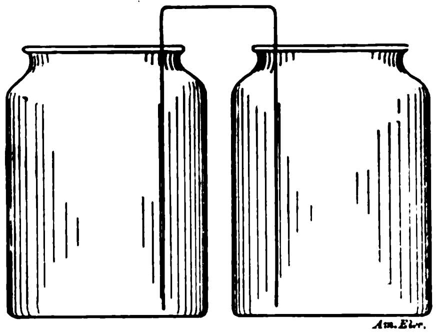

FIG. 1.—ARRANGEMENT OF CELLS.

It is conceded that the only practical way to test insulation is to subject it to a pressure of at least 100 volts and preferably more, and to measure the current flowing, which is conveniently done by means of a voltmeter, the formula being

$$R = \frac{(E - V)\, r}{V},$$

where E is the line potential, V is the reading of the voltmeter, and r is the resistance of the voltmeter. If there is a short circuit V is equal to E and the insulation resistance is O. If V is zero, the insulation resistance is infinitely high, and if it is an appreciable amount the insulation resistance appears in ohms.

In order, however, that this test shall be reliable, the source of potential should be at least 100 volts, and preferably more, and in testing armature coils it is much better to use 1000 volts. But it is advisable that the means of producing this potential shall be such that in case a short-circuit does occur the damage will be limited to the point of break-down and will be in any event very small. In other words, we must have a source of potential which will "lay down" when an appreciable current is drawn from it. In alternating-current work this is conveniently obtained by the use of a very small transformer, but alternating current is not always available and small transformers with high voltage coils are usually special and sometimes not to be had. Moreover, in alternating current work the voltmeter test is not convenient because the deflections are sometimes very small and on small deflection work an alternating current voltmeter is very deficient.

A convenient source of direct current at high voltage and small current capacity can be obtained by the use of a storage battery of many cells. These cells can be so cheaply constructed and so readily arranged and charged, and they are so nearly indestructible, that they are well worth the trouble. The cells are best made of small, wide-mouthed bottles which can be bought for a fraction of a cent apiece of any dealer. One-half as many bottles as volts will be required. The elements in the cells are simply strips of ordinary commercial sheet lead, which should be cut to fit the mouth of the bottle conveniently and bent into U shape so that the legs can be inserted in two bottles placed close together side by side and will just clear the bottoms of the bottles, as shown in Fig. 1.

The cells are conveniently arranged in banks of 50 each, which will enable them to be readily charged in multiple from a source of potential 110 to 115 volts. They can then be connected in series, and 10 such banks will give a potential of 1000 volts. A wooden frame made of strips of half-inch lumber, as shown in the photograph, makes a convenient support for such cells and can be equipped with binding posts along the side members, which will allow the cells to be conveniently connected in series or multiple.

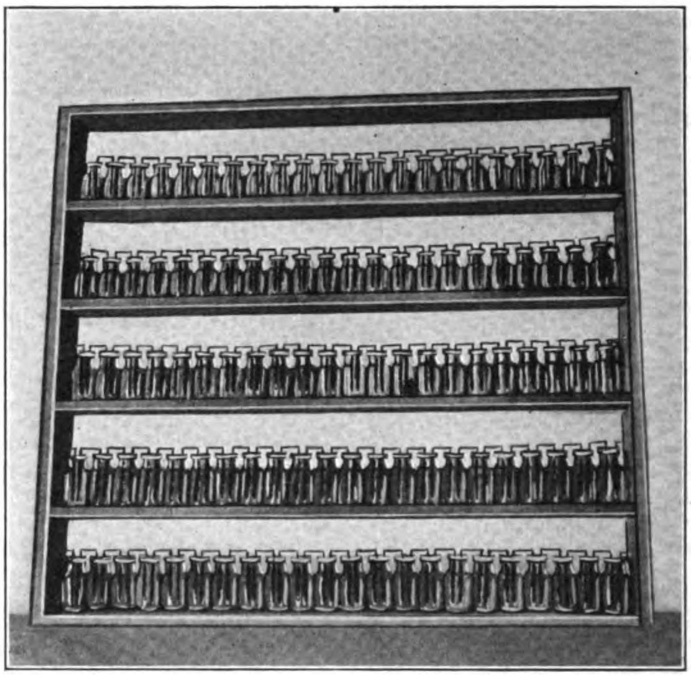

FIG. 2.—HIGH-VOLTAGE TESTING BATTERY.

The formation of the plates of these cells will give some trouble unless certain precautions are taken. If it is attempted simply to put the lead plates in the bottles, fill the latter with storage battery solution and charge, the cells will fill with a fuzzy brown deposit which will quickly bridge across from plate to plate and give a great deal of trouble; moreover, their capacity will be very limited. They will almost immediately lose their voltage as soon as they are disconnected from the charging mains. In order to form such cells properly, the cells should first be filled with clean water and a drop of nitric acid put in each bottle; then the banks of 50 cells each should be connected in multiple and connected to the 110-volt circuit. A tree-like crystal deposit will immediately form on the plates and rapidly bridge across them; this will be very flimsy in its structure and readily detachable. Half an hour of charging will thoroughly oxidize the plates and cut off any grease which may be on them. They should then be removed from the cells and all the loose deposit shaken off, and the bottles themselves should be emptied, thoroughly cleaned and filled with storage battery solution, that is to say, acidulated water of about 1.200 specific gravity.

On reassembling the cells they should be connected to the mains again and charged, and after the positive plates have shown a distinct brown, they should be discharged into a bank of lamps and connected up the *reverse* way and charged again. This should be repeated some ten or fifteen times. The formation of active material becomes deeper and deeper as the process proceeds. It will be found that 15 minutes' charging will suffice to completely reverse the cells. After these reversals have been made for a sufficient number of times to form a good coat of active material, the cells should only be charged in one direction whenever they are used. They will lose their charge over night, but they can be readily charged in half an hour, and once charged will deflect a voltmeter steadily for an hour or more, after which 10 or 15 minutes' charging will refresh them so that they will be good for another hour. As voltmeter currents are the only currents to be drawn from such a battery they will be found amply sufficient for test work.

The only attention that the batteries require is an occasional filling with water, and charging when necessary, and they are a very useful source of electromotive force for insulation tests and voltmeter calibration. The photograph shows a bank of 110 cells arranged for such work. The cost of material for a complete outfit of 500 cells should not exceed $10.00.

BOILER ROOM MANAGEMENT.

BY WALTER W. EDWARDS.

It is a noticeable fact that the major portion of the questions asked of applicants for license pertain to the handling of boilers. The reason for this striking feature of such examinations is not far to seek. It is in the boiler room rather than the engine room that the possibilities of widespread destruction and disaster lie, ready to break forth at the first careless oversight on the part of the engineer. A wrong move in the engine room may mean a few hours delay or a few dollars in damage, but with the exception of fly-wheel accidents, there are none of the terrible possibilities, which occasionally become facts in the engine room that there always are around boilers, hence the examinations for license are always framed so as to thoroughly test an applicant's knowledge of boiler management.

In this article it is assumed that an engineer has been given charge of a battery of boilers that has been idle a few days, with orders to get it ready for steaming, say a week later. Under such circumstances and with such orders, a thorough and capable engineer would trace each pipe and connection in order to see exactly where it leads, what valves there were in it, and whether or not it was leaking at any point or was otherwise in bad condition. The valves especially should be examined to see if they are leaking or in need of packing. An experienced eye will at once detect a leak around a valve stem from the peculiar coloring and dirt due to the blowing of steam, but whether a valve allows steam or water to leak through when it is closed is not so easily told by an examination when the pressure is off.

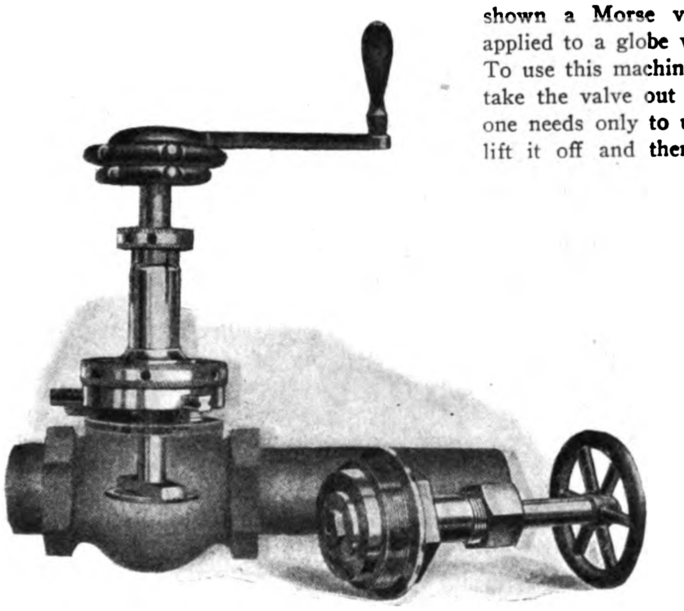

FIG. I.—VALVE RESEATING MACHINE.

The best course to pursue with ordinary disc valves is to remove the bonnet of the valve, and then carefully examine the surface of the valve disc where it comes in contact with its seat. If at any point it is seen that the surface is not bright in a continuous band all the way around the beveled edge of the disc, it may be safely assumed that the valve leaks. To repair such valves it is often only necessary to grind the valve in; this is done by first cleaning the valve and valve seat with spirits of turpentine and a handful of waste and then covering the bearing surface of the valve with a little lubricating oil and ground glass, after which the disc is replaced and turned back and forth on its seat until the high places are ground down and the disc bears evenly all around. The disc may be turned on its seat by tightly wedging a wooden piece in between the lugs on the top of the valve where the valve stem goes, in such a manner that it extends up from the valve so that it can be grasped. In grinding in a valve care should be exercised to turn it around every minute or so in order to prevent wearing the disc or seat more at one point than another.

If the valve is deeply cut or scored at some point on either the disc or the seat, it would mean too much labor to grind the defect out, and in such a case recourse must be had to a reseating machine, several of which are on the market. In Fig. 1 is shown a Morse valve reseating machine applied to a globe valve having a flat seat. To use this machine, it is not necessary to take the valve out of the pipe line at all; one needs only to unscrew the bonnet and lift it off and then place the machine in position as shown. The chuck that holds the machine in place is provided with stepped jaws; by turning the cap on this chuck until the jaws engage the threads on the body of the valve, the spindle of the machine is firmly held centrally in the opening. Next, the lower of the two hand wheels at the top of the spindle is turned so as to bring the cutter shown at the lower end of the spindle down against the valve seat. This cutter can now be rotated by turning the upper hand wheel by means of the crank, truing up the seat within the valve and making it as good as new. The stepped jaws of the centering chuck have a different pitch of thread on each step so that as the threads on the body of the valve become coarser as the valve is larger, the outer steps or shoulders having coarser threads are brought against the corresponding threads of a larger valve body. A flat cutter is shown in the engraving; of course, if the valve to be repaired has a taper seat, this cutter must be unscrewed and a suitable one put in its place.

If the valve disc is to be recut, the spindle shown in Fig. 1 is secured in a sort of lathe headstock, as shown in Fig. 2, and the valve disc, 3, is caught in a chuck on the end of the spindle as shown. The tailstock, 5, is moved along the guide, 4, so as to steady the valve disc for cutting. The cutting tool is secured in the end of the tool rest, 2, and is moved back and forth across the valve face as the valve is rotated by means of the crank. The tool rest is pivoted so that its angle may be changed to suit the angle of the valve disc. The whole machine may be conveniently held in a vise for this work. This machine will take nearly all the common sizes of work, but very large valves must be trued up in a lathe. It is best in doing this work to true up the valve seat first, and then take the angle of the cutter used for truing the seat to set the top slide of the tool rest for truing the disc. To test the accuracy of the work, it is well to make several chalk marks across the disc face and then put it on its seat and give it one or two turns; if the marks are obliterated their full lengths, it is certain proof that the disc face has been cut at the right angle.

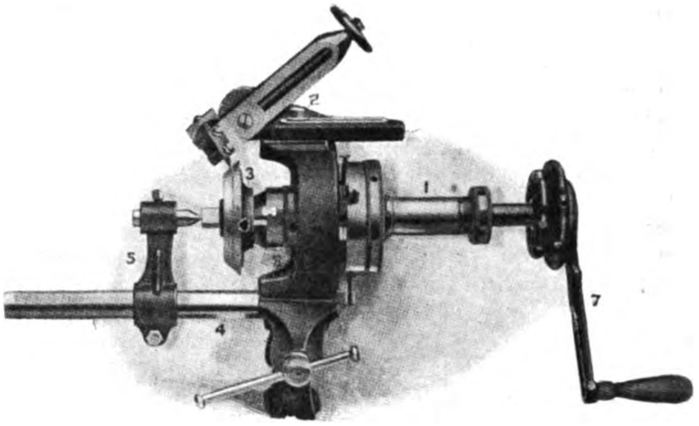

FIG. 2.—VALVE CUTTING ATTACHMENT.

A leaking plug cock is about the hardest to make tight of any valve with which an engineer has to deal. The extent of surface that must be ground away in order to work out a low spot in the plug or plug chamber is so great that ordinary grinding with oil and powdered glass is of no avail whatever. The only way to stop a leak in a plug cock caused by the metal being eaten away is to draw four lead pencil lines down the sides of the plug at about 90° apart, and then insert the plug in the chamber and give it two or three short turns back and forth; upon removal, the pencil lines will be obliterated on the high parts of the plug. The surface of the plug in the immediate vicinity of the obliterated lines should then be taken down with a fine file. When a good bearing is obtained all over the plug, a little grinding with glass and oil will usually make it hold. If it does not, the best thing to do is to get a new cock.

The next to claim attention should be the boilers themselves. All the doors and manhole plates should be removed, and the boilers thoroughly examined inside and out.

While on the inside of the boilers, particular attention should be paid to evidences of corrosion. This will be especially marked along the water line of the shell and along the line of the grate bars if internal furnaces are fitted. If the plates are at all corroded, they should be made perfectly clean and then painted with red lead and boiled linseed oil in order to prevent further corrosion.

Particular attention should be paid to what may be termed uniform corrosion to distinguish it from irregular wasting away or pitting. The writer has seen boilers in which the corrosion was so uniform and even and yet so extensive as to be positively dangerous, without having the appearance of being corroded at all. Perhaps no more striking illustrations of this could be found than the examples shown in Figs. 3 and 4.

In Fig. 3 is shown a section through the shell and steam dome of an ordinary tubular boiler, in which the corrosion was so uniform that the boiler was continued in use long after the danger line had been passed. The heads of the rivets holding the dome on the shell had been entirely eaten away, and the dome was actually taken off the boiler by driving the rivets back with a hammer. No other tool was used. The original thickness of the plate is shown by the dotted line around the inside. Fig. 4 shows another case in which the flat surface of a boiler was eaten away. The boss left under the inside nut was mistaken for a washer by the engineer, and this boiler was used under full head of steam until, in retubing it, the true state of affairs was revealed. The fact that uniform corrosion is very rare is at once a blessing and a curse; if it were more frequent it would be looked for more frequently and sooner detected, and if it were less frequent fewer lives would be lost.

When valves and the interior of the boilers have been carefully gone over and the furnaces have been inspected, the boilers should be closed with the exception of the upper manhole plates, which it is better to leave off until the boilers are filled to the steaming level. Water can be run into the boilers from the water main through the usual feed connections until it begins to show in the glass. At the first indication of water in the glass, the feed on that boiler should be stopped and a man sent into the boiler to measure the depth of water over the highest point of the heating surface. This measurement should be entered in a note book and carefully kept for future reference. After this the boiler may be filled to steaming level, which is usually about one-half the height of the glass, and the upper manhole plates put on.

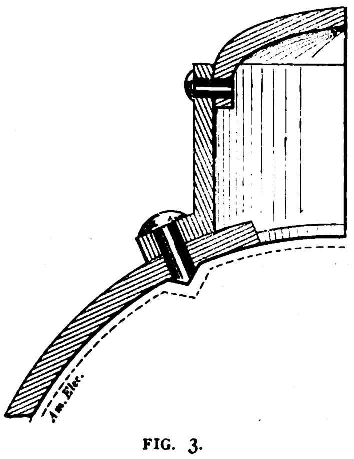

FIG. 3.

In preparing to light fires, it is usual first to cover the whole grate surface with coal and then put in wood. The object of first covering the grates with coal is to restrict the draft to the point in front where the fires are lighted. When the wood is well alight, more coal should be added. The fires should not be disturbed much if anthracite coal is used, as a hard coal fire will not stand much poking. With soft coal, the case is wholly different, and only a very little fire is needed to fully ignite the whole furnace charge. With this coal, as fast as it becomes thoroughly ignited in front, it should be pushed back so as to cause the entire charge to burn evenly through the furnace.

Steam should never be raised quickly on a boiler except under the most urgent circumstances. Nothing will make an old boiler out of a new one in less time than the practice of lighting fires, opening all the dampers, and "pushing her for all she is worth." Steam should not be allowed to form in less than from 3 to 12 hours, depending on the size of the boiler. (Steam may be generated in water-tube boilers in much less time; hence this remark only applies to shell boilers.) If the boiler has separate furnaces, fires should be first lighted in one of the outer furnaces, as this will cause the water to rise on that side and go down on the other so that circulation is very effectively established. There are several devices on the market for causing artificial circulation, and a better investment cannot be made than installing a good one.

Some feed pumps are connected to the bottom blow-off so that they may be used to empty a boiler, and where this arrangement exists, it is advisable to use the pump as a circulator to draw water out at the bottom and deliver it back into the boiler at another point; this being only possible, of course, when enough steam has been formed to run the pump. After the boiler has been thoroughly warmed up, fires may be lighted in the other furnaces. Where there is only one furnace, it is usually so arranged that the grate is beneath only the front part of the boiler shell, and the circulation is set up by the water rising in the front end, flowing back along the water line, and dropping at the rear where the heat is least.

While steam is being raised it is well to lift the safety valve in order to see that everything is clear and that it will operate. The practice of lifting the safety valve without steam in the boiler, which is followed by many, cannot be condemned too strongly. Sooner or later dirt or grit will be loosened so that it falls on the valve seat, and when the valve comes down on it, either the valve disc or the seat is scored, causing the valve to leak. By raising the valve when there is pressure on the boiler, any dirt that may be dislodged is at once blown out of the escape pipe. A drain should always be fitted to the lowest point of the escape pipe in order to prevent the pipe from filling with water, and thus causing an increase in the blowing off pressure because of the hydrostatic head of water pressing on the valve. It is also well to put a screen over the end of the pipe to keep birds from building their nests in it. The water column should also be tested before the steam pressure is high, to see that it is in working order.

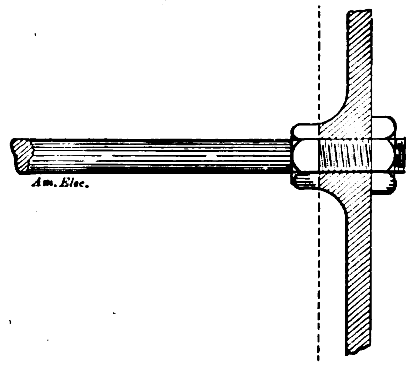

FIG. 4.

There are three systems of firing in general use; these may be termed the dead plate or coking system, the alternate system, and the spreading system. In the dead plate or coking system the coal is piled in the front of the furnace and there allowed to ignite from the fire underneath and back of it. This system is especially well adapted to bituminous coal, as the hydrocarbon gases that are distilled pass back directly over the fire and are burned; later the coke that is left on the dead plate is pushed back and a fresh charge is put on in front. This system would be almost useless with anthracite coal, as there are little or no hydrocarbon gases to drive off and burn, and it is also characteristic of hard coal that it must not be stirred if the best results are to be obtained. So pronounced is this latter characteristic that if an anthracite fire is stirred and has begun to die, it is best to haul it out completely and build a new one rather than try to nurse the old one back to life.

In the alternate system of firing, first one side and then the other is covered with fresh coal. This system always keeps one side uncovered so that the gases that are distilled from the fresh fuel are ignited and therefore do not pass up the stack unconsumed. It is equally well adapted to both hard and soft coal, and is deservedly popular with engineers. This system undoubtedly has the disadvantage of requiring more skill in firing than does the dead plate system, as it is not easy to spread a shovelful of coal evenly over a large area.

The spreading system is where the coal is spread evenly over the entire surface. This method requires that but little coal shall be put on at a time, as a heavy charge would lower the temperature of the furnace and cause a loss of fuel through the formation of carbon monoxide. It is usually used when firing the smaller sizes of anthracite.

The desirable thickness of a bed of burning fuel is one on which there is considerable difference of opinion. Some engineers prefer a thick bed of fuel because such a fire is less sensitive to changing conditions, and is not so apt to burn through in spots and allow cold air to rush into the furnace and chill the boiler plates. On the other hand, a thick fire retards the draft and is more apt to cause a loss of fuel through imperfect combustion. It is also evident that the doors must be opened oftener when fires are kept thin. It is probable that the best results will be obtained when a compromise is effected between these conflicting conditions and a medium thickness of fire is maintained. Where several furnaces discharge into one stack it is of the utmost importance that the fires be kept of the same thickness; otherwise the thin fires will burn out first because they get most of the draft. It is an old trick of the lazy fireman, where there are several on a watch, to keep thicker fires than his neighbors, as he does not have to handle as much coal. Moreover, he gets the reputation of being a very economical man, as there is less coal delivered to him than to the others.

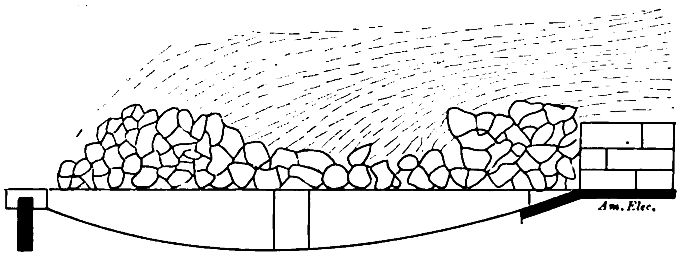

FIG. 5.

The evils of uneven firing are fairly well indicated by Fig. 5. Here is shown a thick bed of fuel in front, a thin bed in the middle, and back against the bridge wall it becomes thick again. The natural result of such firing is that the fire burns through in the thin places, because the draft is very much greater here than elsewhere, while the points at which the fires are thick do not get sufficient air for complete combustion, thus producing a waste of fuel. When the fireman replenishes the fires it is more than probable that the hollows are filled up with green coal which, as it has no burning fuel beneath, does not readily ignite. Combustion will now be fiercest where the thick places were before coaling, and these soon burn out, making thin spots, and the whole wasteful operation is repeated. No truer sign of a good fireman is to be found than an even fire.

It should be the aim of a fireman to maintain the steam pressure as near constant as possible. The direct effect on the boiler of a varying pressure is ruinous, as the varying pressure means a varying temperature, with its attendant expansion and contraction of the boiler. Another advantage of maintaining a uniform pressure is an indirect one. If the pressure is constant, it means that the furnace temperature has been maintained without much fluctuation, and this always is conducive of economy of fuel. A uniform water level means vigilant care and may generally be said to be characteristic of good fireroom management.

When shutting down for the night it is necessary to preserve the fires in some way and yet prevent them from developing enough heat to raise the steam pressure. This object is accomplished by banking the fires. A fire to be banked is first allowed to burn down fairly well, and then it is all pushed back against the bridge, leaving the front of the grate bare, or it is all pulled forward, leaving the back of the grate bare, and then covered heavily with fresh coal. When the fire is pushed back it tends to choke the passage over the bridge, and as all the air that passes through the boiler must pass over the fire, it is quite hot. As there is sufficient heat present in this hot air to more than maintain the steam pressure, it is more usual to bank in front and allow cold air to pass through the back of the grate and up the stack. This latter method is more injurious to the boiler than the former, but as it is more effective in keeping down steam it is much oftener used.

Before leaving the boilers they should be pumped up until every glass gauge is nearly or quite full of water, so that the morning engineer will have a chance to use the bottom blow-off without bringing the water below the steaming level. It is in the morning before the fires are spread that the sediment and dirt in the water is most apt to be on the bottom; hence the morning is the best time for blowing down.

In conclusion, attention should be called to the fact that an employer is very apt to judge his engineer and fireman by the general appearance of the steam plant. The extra labor involved in keeping brass work bright, floors swept, and boiler fronts painted with boiler paint is small, and no engineer who is mindful of his own best interests will neglect these points.

HINTS ON HANDLING BOILERS.

Can a boiler be forced as hard when fired by automatic stokers as when fired by hand? In the N. E. L. A. *Question Box* this inquiry is answered both in the affirmative and in the negative. The "average" of the opinions, however, appears to be that if the stoker is adapted to the grade of coal being burned, and is a first-class apparatus, the boiler can be forced about as hard as with hand firing. No sweeping reply to the question can possibly be correct, for the reason that the conditions of operation have everything to do with the problem. Probably the reply of Mr. W. L. Abbott, of the Chicago Edison Company, fits the case as well as anything short of an analytical discussion could; he expresses the opinion that with the same draft conditions a boiler can be forced harder when fired by hand than when automatically fired, unless the stokers are arranged so that the fires can be readily raked and stirred.

Concerning the cleaning of a water tube boiler, the majority of the opinions expressed in the *Question Box* are to the effect that the hand-hole covers in the rear section should be removed while cleaning, so that the worker can *see* whether or not the cleaning is thorough; it is not at all safe to rely upon the blow-off to complete the job. Practically all of the covers in the front heads of a water tube boiler should be removed for cleaning out, and the hand-hole covers should all be marked for identification so that they can be put back exactly as they were before removal. Of course, when new gaskets are to be put in, this is not strictly essential.

THE ADVANTAGES OF CONDENSING.

It is one of the more recent dogmas that there is but little if any advantage in using condensing engines when high boiler pressure is available. This fallacy has obtained quite a considerable sway of late years, especially in regard to electrical working. When boiler pressures were only 20 to 30 pounds, it is evident that even without any expansion whatever, an additional 15 pounds due to condensing was a very substantial addition to the mean pressure available from an initial pressure in the boiler for the above small amounts. With boiler pressures of 150 pounds, a superficial thinker may, perhaps, look upon an extra 15 pounds as too trivial to take into account. Let the actual facts of practice be considered, however. A modern engine too frequently has the fault that it does not get anything like full boiler pressure upon the piston unless at full load.

An ordinary compound engine at 75 per cent. of its normal load will show a mean pressure referred to the low-pressure cylinder of perhaps 30 pounds. If the engine is of small size, it will be running on an average load of not more than half the normal rating, with a mean cylinder pressure of about 20 pounds. Under circumstances of this kind the power given by condensing working is relatively very large, and it cannot be urged with any show of reason that a traction load can be run economically by a non-condensing engine. The error has arisen, in all probability, as the outcome of earlier days of electrical working, when only lighting was undertaken. The maximum peak of a lighting load is of very short duration, and it can be got over by running a cheap and uneconomical engine for a very small part of the time. In such a case a certain amount of reason can be advanced against the use of expensive plant to get over a peak of short duration. But a traction load bears no resemblance whatever to a lighting load. Its peaks occur every few minutes or every few seconds. It is impossible to put on and take off an engine to suit the momentary fluctuations. The same engine must run, at one moment carrying a load of 150 per cent of normal, the next carrying but 30 per cent of normal.

Without a battery to equalize the load

on the engine, it is simply out of the question to expect economy from an engine so loaded, but there is no reason whatever for employing a larger non-condensing engine, when one of two-thirds the size, or even less, will turn the same load when condensing.

The economical load of a factory engine asks for 40 or 45 pounds mean cylinder pressure. When only 25 or 30 pounds can be secured it is impossible to have economy, not only because the engine frictional loss is great in proportion to the useful load, but because all other losses are increased, notably, those due to cylinder condensation.

The effect of a battery and reversible booster is to enable an engine to run at a higher mean cylinder pressure, for the necessity is abolished of coping with maximum load peaks by the unaided engine. Without a battery the one engine has to be aided by a second engine. The economy of a battery comes in the abolition of the second engine, with its duplication of losses. There is no economy to compare with condensing when applied to a traction plant, unless it be the battery which equalizes the engine load. Unfortunately, it is only too common to find the benefits of condensation thrown away to a very considerable extent. —London *Electrical Review.*

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THE THREE-WIRE GENERATOR.

The three-wire generator is a direct-current dynamo giving the full over-all voltage at the brushes and having a third terminal, which is connected to the neutral of the three-wire system. This third terminal is connected to the middle point of an auto-transformer or "balancing" coil, the terminals of which are connected to points of opposite potential in the armature winding of the generator. The function of the auto-transformer may be better grasped perhaps by considering the elementary properties of such a device.

If a coil of wire, wound on an iron core, such as is used in transformer construction, be connected to an alternating-current circuit of 100 volts potential, and a tap be led out from the middle of the coil, as indicated in Fig. 1, a voltmeter applied to the wires *a* and *b* will, of course, indicate 100, and if it be connected to the wires *a* and *n*, or to *b* and *n*, it will indicate 50 volts, or one-half of the over-all voltage. The reason will be clear upon a little consideration. The impedance of the two parts of the coil on each side of the neutral or center tap is exactly the same; consequently, the impedance "drop" in each half is the same, and the sum of the two "drops" is equal to the over-all e.m.f. If the tap were connected in at a point one-third the way from one terminal of the coil, the e.m.f. between the tap and the nearest terminal would be one-third of the over-all e.m.f., and so on, for any other division of the winding.

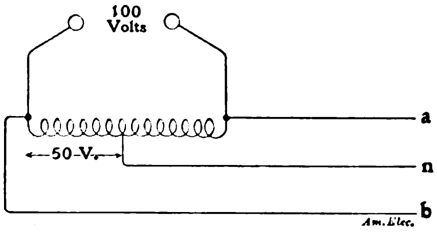
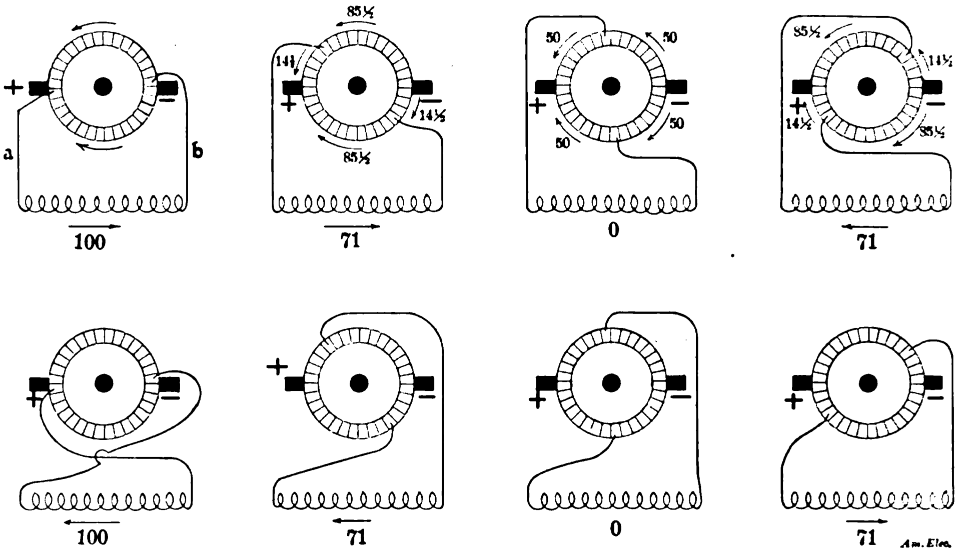


FIG. 1.



FIGS. 2 TO 9.

If a load, such as a group of lamps, be connected between the wires *a* and *n*, the voltage between those wires will drop slightly below 50, because the additional current flowing through the lamps will increase the "drop" in the right-hand half of the winding. The drop will not be as great as one would think, however, because the additional current flowing through the *left-hand* half of the coil will induce an e.m.f. in the right-hand half, which tends to compensate for the drop in that half of the winding. Therefore, if groups of lamps be connected on both sides of the neutral, the voltage between the neutral and each outer wire will be maintained almost equal even if the groups are not alike in current requirements.

The balancing coil of a three-wire generator acts exactly like the auto-transformer. It receives alternating current from the armature winding, as consideration of Figs. 2 to 9 will show. The diagrams show the connections for a bipolar machine, for simplicity; one terminal of the balancing coil connected to one point of the armature winding and the other terminal to the opposite point. If the e.m.f. at the brushes is 100 volts, this e.m.f. is applied to the coil when the armature coils to which it is connected are in immediate connection with the brushes by means of the commutator, as in Fig. 2. When the armature has turned through one-eighth of a revolution, the e.m.f. at the terminals of the balancing coil will have dropped to about 71 volts, as indicated in Fig. 3, because the e.m.f. induced in that part of the armature winding between the positive brush and the left-hand tap neutralizes an equal part of the e.m.f. induced in that part of the winding between the negative brush and the same tap. The arrows and numbers indicate the various e.m.f's. At one-fourth of a revolution, the e.m.f. at the balancing coil terminals has dropped to zero, as indicated in Fig. 4. Then, as the armature proceeds, the e.m.f. begins to rise in the opposite direction, and at one-half revolution (Fig. 6) it is 100 volts again, but opposite to its original direction. These eight diagrams show the complete cycle.

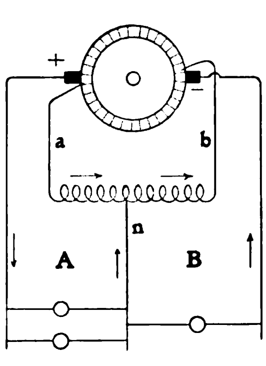


FIG. 10.

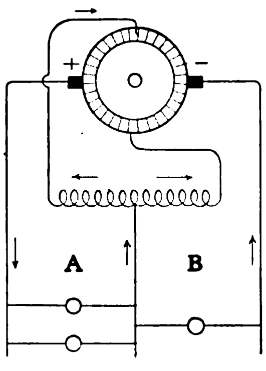


FIG. 11.

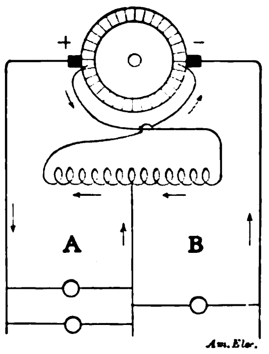


FIG. 12.

Figs. 10, 11 and 12 show the relations with an unbalanced load for the three principal positions of the armature. The current for the two lamps in the *A* side goes from the dynamo brush out over the positive wire, and through the two lamps; at the neutral wire it splits, half going through the *B* lamp and back over the negative wire. The other half, required for the second lamp on the *A* side, goes back over the neutral wire, *n*, and combines with the current in the right-hand half of the balancing coil, returning thus to the armature coil at the negative brush. In Fig. 11 there is no e.m.f. at the terminals of the balancing coil, so that the return current from the neutral wire, *n*, divides and passes through both halves of the coil to the armature winding. In Fig. 12 the conditions are exactly opposite to those in Fig. 10; the current from the neutral wire returns to the armature winding through the left-hand half of the balancing coil. It will, or should, be obvious from these three diagrams why the current in the balancing coil is alternating, while that delivered from the neutral wire to the coil is direct; the neutral current simply enters the balancing coil at the middle and passes through first one half and then the other, according to the directive effect of the e.m.f. applied to the coil by the armature winding.

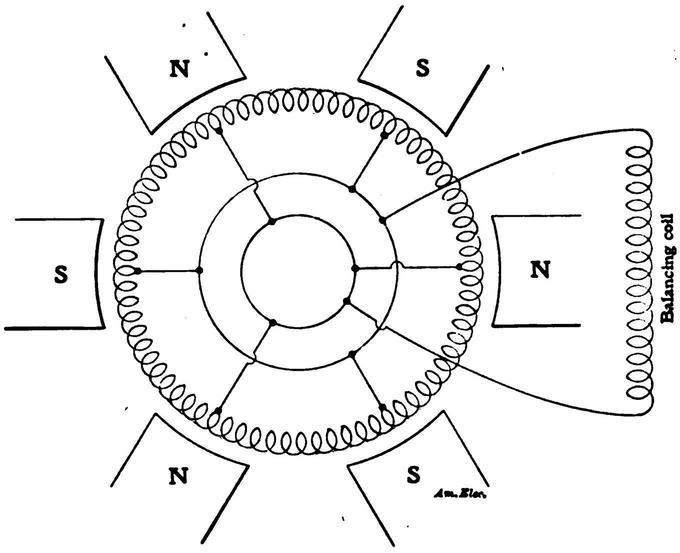


FIG. 13.

In practice, three-wire machines are multipolar, but this does not affect the functions of the balancing coil; one of its terminals is connected to all of the points in the armature winding that are of equal potential at any given instant and the other terminal is connected to all the points that are at equal but opposite potential at that same instant. Fig. 13 illustrates this diagrammatically.

The balancing coil may be mounted on the armature spider, with its terminal connected directly into the armature winding and its middle point connected to the neutral wire through a slip ring and brush, or it may be stationary, with its middle point connected solidly to the neutral and its terminals connected to brushes which bear on slip rings connected to the armature winding like those of an ordinary alternator. It is usually preferred to mount the coil on the armature structure; this reduces the number of slip rings to one and provides very effective ventilation of the coil by fanning. It is also the practice to use two or more balancing coils connected to equidistant points in the armature winding in order to smooth out the fluctuations in the neutral circuit.

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Electric Railway for Mont Blanc.—M. Baloit has prepared plans for an electric railway to be built up Mont Blanc. The cog-wheel system will be employed. In the ascent of 11,710 feet the road will traverse eleven miles.

ALTERNATING-CURRENT SUB-STATION OPERATION.

BY S. L. PEARCE.

There are three possible ways of starting up a rotary converter. (1) From the alternating current side by switching it straight on to the supply lines. This method was adopted, and as far as the author knows, is still in vogue on the Central London Railway system, and on the Liverpool and Southport line, in the case of the first rotary to be started up each day. It is necessary to have a field-splitting switch in order that the shunt winding may be opened before starting, otherwise they would break down owing to the excessive e.m.f. induced at the moment of closing the alternating main switch. Further, if the rotary be compound wound, the series field windings must be open-circuited. All switches on the direct-current side must be left open before switching the rotary on to the line. By reason of the hysteresis lag in the pole faces, and in a lesser degree due to the eddy currents set up, the rotary will start as soon as the alternating-current switch is closed, and will immediately run up to synchronous speed. As soon as synchronism is attained, the field-splitting switch and direct-current field switch can be closed. With self-exciting sets care must be taken to see that the latter is closed as the machine is building up on the right polarity, which can be done by closely observing the direct-current voltmeter. If this is not done, the polarity on the direct-current side of the rotary will be reversed.

The rotary will now be running in synchronism with the main generators, and can be paralleled on the low tension bus-bars in the usual way. Although this method may be unavoidable in some cases, it has serious disadvantages, chiefly on account of the large current at low power-factor which it draws from the supply lines, and the possibility of the rotary building up on the wrong polarity. For traction work this method may be employed, but not for lighting purposes.

(2) Starting up from the direct-current side. This is a far simpler operation, presents no difficulties of operation, and can usually be followed in most instances where a supply of direct current in the sub-station is available. In the case of the Central London Railway this method was always adopted for all sets after the first. For lighting systems the starting current required for large units might occasion a heavy drop on the distributing mains, and it will become necessary either to provide an induction motor generator set to supply the necessary direct current, or, better still, the third method may be usefully employed.

(3) This consists in coupling on to an extension of the rotary shaft a small, three-phase, low-pressure induction motor, the capacity of which should be approximately one-tenth of the full load output of the rotary. By means of this starting motor, the whole set may be brought up to synchronous speed, the alternating-current and direct-current fields adjusted, and then synchronising the alternating current side of the rotary on to the line, afterward cutting out the starting auxiliary unit.

The starting up of synchronous motor sets presents no difficulties, and is usually done from the direct-current bus-bars, synchronising on the alternating current side in the usual manner. It is, however, absolutely necessary that provision be made in every sub-station for the plant to be started up from the alternating-current side in the event of a possible shut-down of the lighting or traction systems. Such means are to hand in the employment of induction motor sets, which in lighting sub-stations are frequently coupled up to the balancers. Their value in this respect forms good reason why a combination of induction and synchronous motor sets is desirable. If battery power is available, this will provide the alternating direct-current supply, but it rarely happens that battery stations and polyphase sub-stations are combined.

A method of starting up applicable to both rotaries and synchronous motor generators is shown in the accompanying diagram, and is a slight modification of the first method described for the starting up of the former. The compensator reduces the primary voltage to one-half, the double throw oil switch, which is fitted with an over-load device, being thrown down to the bottom contacts. Half voltage is thus impressed on the rotary, or synchronous motor, and the field switch being left open, the machine runs up on an induced field. When full speed is attained, and the field built up in the right direction, the field switch is closed, the oil switch is thrown over on to the top contact, i. e., on to the full voltage bars, and the starting high tension oil switch is withdrawn.

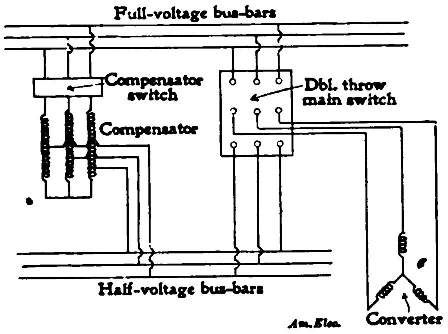

FIG. 1.

The motor generator with induction motor is the simplest of all types of sub-station equipment to start up. With long feeders it is desirable that the pressure on the feeders should be applied gradually to the stator of the induction motor, as any throw-up in the voltage due to the capacity of the feeder at the moment of switching on might break down the insulation of the motor. A suitable design of three-phase stator starter to be used for the purpose consists of three coils arranged in a triangle, and carefully insulated by cylinders of mica. Each coil is provided with an adjustable core consisting of a large number of iron sheets 1/50-in. thick. The three iron cores are attached to a round disc, which is held by a three-armed cast-iron holder, through the middle of which runs a screw, and the three iron cores can thereby be raised and lowered. The three coils are switched in series with the corresponding phases of the motor which is to be started up.

Before switching in, the iron cores are lowered into the coils so that on first switching in only a small current goes into the stator of the motor. The cores are then gradually raised out of the coils, the inductive resistance being thereby gradually lessened, and finally the coils are short circuited. A water resistance or other suitable form of starter is inserted between the slip-rings of the rotor, and short-circuited as soon as the set is up to speed, when the machine can be paralleled in the usual manner on the direct current side.

On account of the heavy rotor cables with large units, it is desirable, to avoid expense, that the rotor starter should be placed as near the machine as possible, and a convenient arrangement is to operate it by means of bevel gearing from the front of the switchboard platform.

Rotaries are invariably self-excited for obvious reasons. There is one strong disadvantage, however, with this method, consequent on the possibility of the rotary reversing while under load. This happened on two or three occasions on the Central London Railway system, and is a possibility to be reckoned with. If the rotaries are excited from the bus-bars, then a battery connected across the bars becomes imperative.

For synchronous sets employed on traction circuits, a separate exciter mounted on the end of the shaft is probably the best method of exciting the high tension motor fields. Although it occupies extra space, it provides an alternative method of excitation from the lighting bus-bars where a mixed system is supplied. In any case it is desirable that the excitation for the traction sets should be independent of the lighting system, and this can best be obtained by the use of a separate exciter, or by a method described later on. For synchronous sets on lighting networks, excitation from the direct-current terminals or low-tension bus-bars will probably be found sufficient. The author considers that the question of excitation is of importance, and should be well considered.

The effective balancing of a three-wire lighting network from sub-stations can be secured by the use of an induction motor coupled to two generators giving about half the pressure across the outers, the whole combination forming an auxiliary set for the supply of direct current necessary to start the larger synchronous units.

It is, however, desirable that additional means of balancing should be provided, either by the use of double-wound armatures with the synchronous sets or other methods. An alternative arrangement has been used extensively in the Manchester sub-stations, and emanates from the Allgemeine Electricitäts Gesellschaft. This apparatus is essentially a choking coil, the ends of which are connected up by means of two slip-rings to the armature of the direct-current dynamo. The slip-rings are connected up to the armature at such points that a normal alternating current at the frequency corresponding to the number of pole-pieces and the revolutions is circulating in the equalizer. The middle wire of the system is connected up to the middle point of the choking coil. If the load on each of the two net-halves is unequal, the over-load on one will pass through the middle wire into the respective side of the equalizer, and through the slip-ring belonging to it back into the armature. This method also provides another supply for exciting current, and if all the synchronous plant in each sub-station is so arranged, it is evident that each set will be self-excited. An out of balance current up to 25 per cent can be dealt with under this arrangement without the difference in voltage exceeding 2½ per cent of the mean voltage.

[The foregoing is part of a paper on "Polyphase Sub-stations," read before the ninth annual convention of the Incorporated Municipal Electrical Association, at Derby, Eng.—EDITOR.]

Lessons in Practical Electricity

TESTING FOR TRANSFORMER LOSSES.

The amount of power absorbed by the core losses in a transformer may be determined with sufficient accuracy by connecting the secondary terminals of the transformer to a circuit of the same voltage as that of the transformer secondary and of the frequency for which the transformer was designed, leaving the primary terminals free and including a wattmeter in the secondary circuit, as shown by Fig. 1. The wattmeter will then indicate approximately the power absorbed by core losses. The object in connecting the transformer up at the secondary end instead of at the primary is to enable one to use an ordinary wattmeter without interposing a transformer between the wattmeter and the circuit. The test could be just as well made on the primary of the transformer if the wattmeter could be connected to the primary circuit. While this test is sufficient for all practical purposes, it is not absolutely accurate, because there is a very small copper loss during the test due to the passage of the exciting current through the secondary winding. This is practically negligible, however, and a test made in this manner answers all ordinary requirements.

The foregoing test, as stated, shows practically the amount of power required to supply the core losses in the transformer, which comprise the loss due to hysteresis and that due to eddy currents. It is not practicable by any convenient method to separate these two losses; moreover, the separation of these two losses is not of any practical importance to the user of the transformer. Should it be desirable for purely experimental purposes to ascertain which of the two losses preponderates this can be done by connecting a voltmeter across the secondary terminals of the transformer, inserting an adjustable resistance in the circuit beyond the wattmeter, and adjusting this resistance until the e.m.f. at the secondary terminals is one-half of the normal value. If all of the core loss were due to hysteresis the wattmeter would indicate practically one-third of the loss that is indicated when the voltage was normal. If all of the core loss were due to eddy currents the wattmeter would indicate only one-fourth of the power indicated when the voltage was normal. If its actual indication, therefore, is nearer one-fourth than one-third of the power indicated with the voltage normal, the eddy-current loss preponderates; and if it is nearer one-third than one-fourth, the loss due to hysteresis is greater than that due to eddy currents.

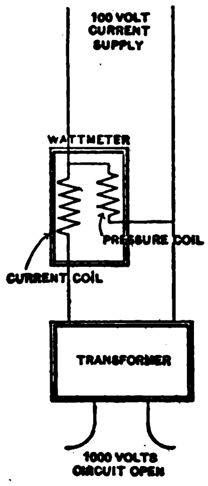

FIG. 1.—CORE LOSS TEST.

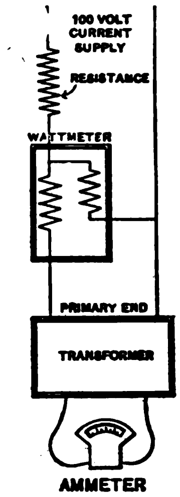

FIG. 2.—COPPER LOSS TEST.

In order to test for copper losses the most accurate method is to connect the primary winding of the transformer in series with an ammeter and an adjustable resistance across a low-potential, direct-current circuit and vary the resistance until the current passed is equal to the full-load primary current of the transformer; then measure the difference of potential at the terminals of the primary winding and multiply this by the current flowing; the result is the copper loss in the primary. Make a similar test of the secondary and add the two results together to obtain the total full-load copper loss.

Another method, which is more convenient but not quite so accurate, consists in short-circuiting the secondary of the transformer through an ammeter, connecting the primary in series with an adjustable resistance across a low-voltage alternating-current circuit of the proper frequency and also connecting a wattmeter in the primary circuit, as indicated by Fig. 2; the resistance is varied until the normal full-load secondary current is indicated by the ammeter, when the wattmeter will indicate approximately the power absorbed by the windings of the transformer. As just intimated, the result of this test will not be absolutely accurate, for the reason that some of the energy supplied by the test circuit is absorbed by iron losses; these, however, are extremely small on account of the low voltage at the terminals of the primary winding.

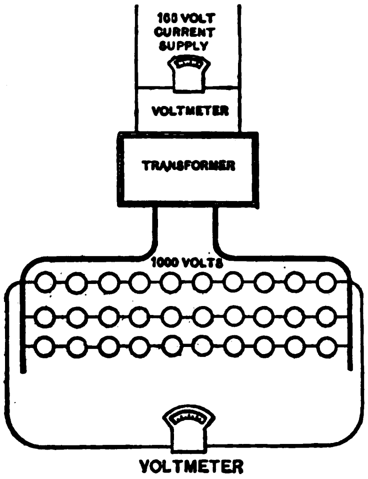

FIG. 3.—TESTING FOR FULL LOAD DROP IN VOLTAGE.

As has been explained in previous Lessons, the eddy-current loss varies as the square of the magnetic density in the core, and the hysteresis loss varies as the 1.6 power of the density; as the density is practically proportional to the impressed e.m.f., the eddy-current and hysteresis losses may be considered to vary respectively as the square and the 1.6 power of the e.m.f. It is evident, too, that at the low e.m.f. necessary to load a transformer short-circuited as shown in Fig. 2, the core loss will be almost negligible. However, should one desire to refine the test a more accurate result may be obtained as follows: Make an initial test as just described and call the result the gross loss; then disconnect the secondary terminals from the ammeter, adjust the e.m.f. at the primary terminals to be exactly the same that it was during the first test; test the core losses as described in the beginning of this Lesson; subtract this result from the first one, and what remains will be the actual full-load loss in the windings.

To test a transformer for drop in secondary pressure it is only necessary to connect the secondary to a supply circuit of the proper voltage, and measure the e.m.f. at the primary terminals with the primary circuit open. Then load the primary circuit with lamps, as shown in Fig. 3 and adjust the voltage at the terminals of the secondary until it is exactly the same as before, and again measure the e.m.f. at the primary terminals. The difference between the two readings of the primary voltmeter divided by the ratio of transformation will give the drop which the transformer will show at the secondary terminals when used in the ordinary manner and supplied with constant e.m.f. at the primary terminals. The object in making this test in the manner described instead of supplying the transformer from a primary circuit and loading the secondary is to avoid as far as possible manipulating the primary circuit. The test as described only requires one to close a switch in order to throw the lamps on the primary terminals, whereas, if the transformer were tested in the reverse manner the e.m.f. at the primary terminals would have to be adjusted by means of a rheostat, which might cause accidental personal contact with the primary circuit and result seriously.

The method of testing transformer losses with which most station men are familiar consists of simply connecting the transformer up to a primary circuit and measuring the current which passes in the primary when the secondary is open. Such a test is entirely worthless in arriving at the core losses, as the current is out of phase with the primary e.m.f., and consequently, multiplying this current by the primary e.m.f. does not give the actual watts absorbed by the core losses. The simple substitution of a wattmeter, as indicated in Fig. 1, in place of a voltmeter and ammeter changes this test from one which means nothing into one which is sufficiently accurate for all practical purposes in central station work.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Mr. Clark's Potential Wire Effect.

To the Editor American Electrician:

Referring to Mr. Clark's communication in the July number, on "An Unusual Potential Wire Effect," I beg leave to submit the following explanation: It was pointed out by Mr. John W. Howell, some years ago, that a current which will produce a drop of one volt in the neutral wire of a three-wire system (in which all three wires are of the same resistance) will produce an unbalancing of three volts; or in general, the unbalancing of voltage will be three times the drop in the neutral. A general proof of this statement might be given, but for the present purpose we may consider several numerical examples.

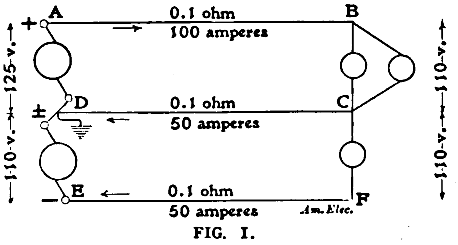

FIG. 1.

Fig. 1 shows two dynamos connected to a three-wire system, the load being unbalanced as shown. For convenience in finding the difference of potential between various points, it will be assumed that the neutral wire is grounded at the bus-bar, as shown, and that the potential of the point, *D*, is, therefore, zero. It is to be noted that this is done only for convenience, and that the result in no way depends upon the fact of this point being grounded. The voltage of each machine being held such that the pressure is 110 volts on each side at the feeder end, we may find the potentials of the points *A* and *E*, as follows: Current flows from *C* to *D*; hence *C* is at higher potential than *D* by an amount equal to the drop in the neutral, or the potential of *C* is + 5. The potential of *B* is 110 volts higher than that of *C*, or + 115; and in like manner the potential of the point *A* is found to be + 125. The potential at the point *F* is 110 volts below + 5, or is — 105; the potential at *E* is 5 volts lower, or — 110. The dynamo on the negative side is, therefore, operated at 110 volts, and the one on the positive side at 125 volts. The unbalancing of voltage is 15 volts, or three times the drop in the neutral.

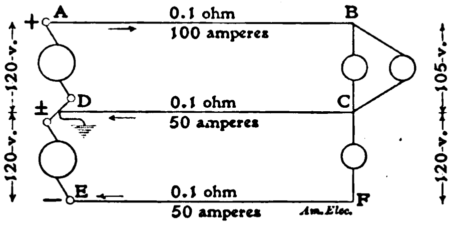

FIG. 2.

Next, assume that the pressure is kept at 120 volts on each machine at the bus-bars, as in Fig. 2. By the same method as in the preceding case we will find the voltage on the positive side at the feeder end to be 105, and that on the negative side to be 120, giving the same unbalancing of voltage, namely, 15 volts, which is three times the drop in the neutral.

In both of these cases the unbalanced load is such that the pressure on the lamps on the negative side is the same as the pressure between the negative and neutral bus-bars. If the load is still more unbalanced, or if the neutral wire is made smaller, we will have the condition Mr. Clark mentions. This condition is illustrated in Fig. 3. In this case the load is assumed to be 150 amperes on the positive side, while the negative side carries 50 amperes, as before. By the method above used we will find that if the pressure is to be kept at 110 volts on each side at the feeder end, the dynamo on the positive side must be operated at 135 volts, and the one on the negative side at 105 volts. The drop in the neutral wire is now 10 volts, and the unbalancing of voltage is 30 volts, or three times this drop, as in the other cases. The pressure between the neutral and the negative bus-bars is now 5 volts *less* than the pressure on this side of the system at the feeder end.

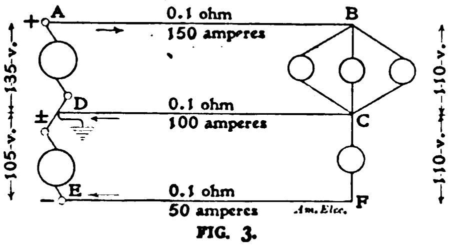

FIG. 3.

In the foregoing examples I have considered the neutral wire to be of the same size as the outside wires. If, as is often done, the neutral wire be made smaller than the outside wires, a given drop in the neutral will be produced with a smaller current, and the effect Mr. Clark mentions will be produced before the unbalancing of the load becomes as great as in the cases considered.

Washington, D. C. H. B. BROOKS.

To the Editor, American Electrician:

The peculiar condition of a three-wire system in which the potential at the center of distribution is actually higher than that of the bus-bars or dynamo on the same side of the system, as described by Mr. H. Lee Clark in the July number, may exist when such a system is considerably unbalanced. As an explanation of this discrepancy in voltage, I offer the following in connection with the potential diagram, Fig. 5, corresponding to the arrangement of apparatus shown in Fig. 4, where *B* and *D* are 125-volt dynamos supplying 400 amperes to a group of lamps on the positive side of the system and 100 amperes to a group on the negative side.

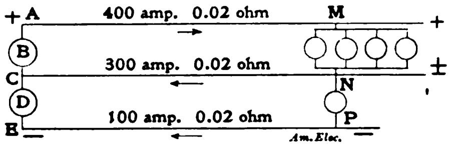

FIG. 4.

Assuming the neutral to be the same size as the main conductors and that the resistance of each of the three wires is 0.02 ohm, the drop of potential on the positive main (between *A* and *M*) will be 8 volts for a current of 400 amperes. The drop on the neutral wire between *C* and *N* will be 6 volts, since 300 amperes must return to the positive dynamo through it. Then a potential of 125 volts at each dynamo will give 111 volts between *M* and *N*. On the negative wire the drop between *P* and *E* is 2 volts; therefore, the potential at *P* is 2 volts higher than that at *E;* but as the potential at *N* is 6 volts above that of *C*, it is evident that the voltage between *N* and *P* is 4 volts greater than that between *C* and *E*, due to the dynamo *D*.

Such a condition is not likely to occur in practice, especially in a large system, where the load is carefully balanced. In case the neutral wire is only one-half as large as the outside wires, which is actually the case in many systems, the discrepancy in voltage would be much larger.

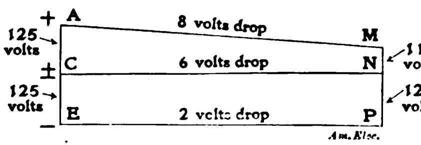

FIG. 5.

Los Angeles, Cal. GEO. A. SCHNEIDER.

[Both of the foregoing letters were received several days before the August number was issued, but too late for insertion in that number.—EDITOR.]

Flashing Over by Rotary Converters.

To the Editor, American Electrician:

Regarding Mr. Jerome's trouble with his rotary converters, the writer is of the opinion that he is operating the machine with the brushes not on the proper point for commutation. The running position is slightly in advance of the no-load neutral point on the commutator and it should be brought as far forward as possible without causing undue sparking. Sometimes it will be found necessary to make the machine spark slightly at the no-load neutral point in order that it may carry its maximum overload satisfactorily. Mr. Jerome should satisfy himself that the brushes are set equidistant apart about the commutator. The writer has found pole pieces spaced accurately mechanically, but not equal magnetically; in such cases the brush-holder stubs should be moved so that the e.m.f. generated between adjacent brush-holder stubs is equal. His trouble may also be due to the fact that he is operating more than one rotary on the same transformer secondary, which will cause undue current to be exchanged between the machines. If the rotaries can be separately excited a more stable field can be obtained than with self-excitation, since the alternating-current voltage fluctuates on the alternating-current side of the rotaries. This will in most cases overcome all flashing over evils. I have cured several 60-cycle rotaries of bucking and flashing over by cutting with a hacksaw a very narrow slit in the carbon brushes parallel to the commutator bars about ⅜ in. deep. This does not reduce the conductivity of the brush, but enormously increases the contact resistance to the short-circuiting currents flowing under the brushes. I have also found that this increases the life of the commutator very materially and does not require the sandpapering of the commutator so often. The brushes should not be shifted too far forward, as the circuit-breaker will open as the load increases and cause the machine to spark badly at this point if overreached. Sparking is also liable to occur when the prime mover or generator momentarily increases its speed, causing a difference in phase between the generator and converters. The difference in the instantaneous e.m.f. due to the difference in phase causes a corrective current to flow in the circuit, which will distort the fields and accelerate the converter armatures, thus placing the commutator coil in a strong field and producing flashing and bucking.

San Francisco, Cal. F. P. DE WILDE.

To the Editor, American Electrician:

Referring to Mr. Jerome's trouble with rotary converters, I would suggest that the flashing over is caused by the improper position of the brushes, the flashing being due to short-circuited coils. I think if he will shift his brushes the flashing will cease

Ladonia, Tex. WILSON A. McCOWN.

To the Editor, American Electrician:

The trouble described by Mr. Jerome in the August number of the AMERICAN ELECTRICIAN is probably due to improper brush contact. I would suggest that the commutator be examined, and if it is in good condition the only remedy is to shift the quadrant so as to cause the brushes to make better contact.

Newark, N. J. JAMES J. FOX.

Fires from Electrical Causes.

To the Editor, American Electrician:

The attention of AMERICAN ELECTRICIAN readers has doubtless been attracted by the great fires of the past year in American and Canadian cities, in which much of the blame was at once laid on electric wires. Every one knows that the Fire Underwriters' regulations call for work and material calculated to make the installations safe to the extreme, and this work is done under the strict supervision of the underwriters' inspectors. No one would think of a fire being started by wiring done under such circumstances. The writer has, however, made note of several fires which have been caught before they reached any magnitude, and in 15 years' experience has yet to see the first fire caused by the wires themselves. The causes of the fires mentioned below were the fault of the apparatus used and not the wires.

In a Pennsylvania town there was a first-class job in house wiring done by a responsible Philadelphia firm. The primary and secondary wires of the transformer accidently crossed on the pole in the street, by which the 2000-volt primary circuit was connected with the house wiring. The result was that all the lamps in the house blew to pieces, and a fierce arcing took place at the fuse blocks, which fired the cupboard in which they were placed.

Another fire was caused by an elevator motor controller; a shunt motor was used, and we all are aware what current a shunt motor takes when starting under load and the field cannot reach its full strength immediately. The operator stopped the car about a couple of inches from the proper level, and this is where the mischief commenced. He wanted to move two inches, so he pulled the switch rope and then threw it off immediately. The switch drew a long arc, which was maintained at the contacts. The motor could not run, owing to the brake being on the machine. The controller burned up, setting fire to surrounding woodwork. In still another case an alternating-current motor controller had a broken coil in its rheostat, and this wire came in contact with the iron case. The controller was operated mechanically by a wire cable and the machinery was thus charged from this faulty rheostat. The lifting cables passed through the ceiling of the top floor of the building, which was covered with ornamental iron ceiling, and when the lifting cable made contact with this tin, arcing commenced, resulting in the burning of the ceiling. We are required to put circular loam over our wires and tack asbestos over everything in order to make it safe, while these other incidents are occurring daily, and there is no enforced protection.

New York. B. THOMAS.

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

Is there any practical method of testing rolled steel or iron shafts by electricity to locate flaws?
W. F. R.

We do not know of any.

What causes a shunt-wound rotary converter to spark at the direct-current brushes when being started up on the alternating-current side?
H. R. B.

The breaking of the short-circuit on armature coils carrying heavy induced currents as the commutator segments pass from under the brushes.

What should be the shortest distance between the centers of two pulleys of considerably different diameters, belted together? W. T. K.

Twice the sum of the two diameters is used by many engineers as the minimum allowable distance; if the diameters are greatly different, we would prefer to make it equal to the sum of the pulley circumferences.

What type of engine is preferable for driving a 2200-volt 120-kw. alternator? (2) Which is preferable for such a case, belt drive or direct connection? (3) Will a 75-ampere double-throw switch be suitable to connect the generator to either of two sets of bus-bars? J. C. F.

This depends largely upon local operating conditions. Speaking generally, a medium-speed, four-valve engine would be suitable; no hard-and-fast rule can be given. (2) Unless floor space is restricted, belt drive. (3) Yes; it must be a double-break switch, of course, the blades being "dead" when not in either set of jaws.

Two transformers with primaries connected to two phases of a three-phase line and secondaries in parallel on both sides of a three-wire secondary system blow fuses as soon as the secondary switches are closed. Why? (2) Cannot the load be distributed by two incandescent-lighting transformers on two phases and a series arc-lighting transformer on the other? I. W. B.

Because the primary currents are not in phase, so that the secondary currents are also out of phase; as the secondaries are in parallel, one of them is a short-circuit to the other when the current in the first one is at zero; at this instant, the primary voltage of the short-circuited transformer is one-half of its rated voltage. (2) Yes, provided you separate the secondaries of the incandescent-lighting transformers.

How does a "compensated" alternating-current motor differ from an induction motor? (2) What class of work is such a motor used for?
H. D. E.

A compensated motor is a series-wound machine, the armature and commutator being similar to the ordinary direct-current type. The "compensation" consists in providing a source of magnetism which neutralizes the electromagnetic reaction of the armature upon the main or working field.

The Thompson-Ryan dynamo is a "compensated" machine, although built for direct-current generation. (2) The alternating-current compensated motor has not come into commercial use to any considerable extent in this country; it is a very recent development. It is especially well adapted to railway and similar classes of service.

What is the work done by a water motor in a stroke of 7 inches, the piston being 4 inches in diameter and the water pressure 120 lbs. per sq. in.? (2) In Ayrton's "Practical Electricity" it is stated that the rate of work in an electrical circuit is $I^2 R$ when there is only resistance in the circuit, but when there is any counter e.m.f. the watts are greater than $I^2 R$, so that $I^2 R$ is less than $I E$. Why is this? R. H. M.

The foot-pounds of work done by a piston under pressure is equal to the pressure per unit of area, multiplied by the piston area and by the distance traveled in feet. In your case, the specific pressure is 120 pounds, the area is 12.566 square inches and the travel is 7/12 foot; hence, the work done is 879.65 foot-pounds. (2) Because there is the counter e.m.f. to be overcome, in addition to the circuit resistance. The watts represented by I^2R are only those expended in overcoming the dead resistance.

A wattmeter plate is stamped "Volts: 110; amps. 300; cycles: 60; secs.: 540." What does "secs. 540" mean? T. C. R.

The instrument is evidently a Stanley watt-hour meter; the inscription "secs. 540" means that in 540 seconds, with a constant load, the revolutions of the disc multiplied by the gear constant (100) will equal the watts passing through the meter. Nine minutes, however, is a rather long test for the disc-revolution method; a convenient way would be to test the meter exactly one minute, in which case the watts in the circuit will be

900 × *total disc revolutions = watts.*

In other words, count the disc revolutions for exactly one minute, deduct 10 per cent. from the number, and the remainder will be the *kilowatts* in circuit.

Why does a motor increase its speed when its field is weakened? (2) Why does shifting the position of the brushes cause a change in speed?
N. J.

Because there is no other way in which it can generate the required counter e.m.f. The counter e.m.f. must be enough to make up the difference between the drop in the armature and the e.m.f. applied to the brushes; it is proportional to speed, number of armature wires and field strength. With a certain applied e.m.f. and load, a certain counter e.m.f. must be generated, and if the field strength is changed, the speed will change automatically so as to make up for the change in field. (2) Because it alters the effective number of armature wires and thereby the counter e.m.f. that can be generated at a given speed; if the effective number of wires is decreased by shifting the brushes, the speed will increase to compensate for it.

In a 1000-volt alternating-current system supplying incandescent lamps only, is there any choice between 60 cycles and 125 cycles frequency? (2) If it should be determined to change a system from 125 to 60 cycles, would it be allowable to install the 60-cycle generators without changing the distribution circuits and transformers? (3) What is the effect of operating a 125-cycle transformer on a 60-cycle circuit? J. M. D.

Not so far as immediate conditions are concerned, but in order to be in position to supply motors in the future it is preferable to install 60-cycle apparatus in a new plant. (2) If the voltage is the same, and the transformers are of modern construction, yes; but any transformers more than five years old should be displaced by modern apparatus. (3) The heating is greater and the internal losses are, therefore, greater; this is due to the increase in magnetic flux in the core, causing larger core losses and slightly larger copper loss. A modern 5-kw. transformer, for example, has a full-load efficiency of 97.1 per cent at 125 cycles and 96.8 per cent at 60 cycles; the half-load efficiencies are 97.2 per cent at 125 cycles and 96.5 per cent. at 60 cycles.

What is the principle of an ammeter shunt? (2) How can a shunted ammeter register the full current? (3) Why are shunts used? J. H.

(1 and 2) The shunted ammeter is based on the principle of divided circuits. The ammeter and its shunt form two parallel branches of widely different resistances, the shunt being of much lower resistance than the ammeter winding. If the ratio is 1 to 99, for example, the current in the shunt will be 99 times the current in the ammeter, no matter what the total current may be; the ammeter, in such a case, would be calibrated to indicate 100 times the current actually flowing through it, since the total current is 100 times that in the ammeter winding. Thus, if the circuit current is 10 amperes, 9.9 amperes would flow through the shunt and 0.1 through the ammeter; the dial would be so marked that with this current the needle would point to 10. If the line current be doubled, the current in the ammeter will be doubled, and the pointer will indicate 20. (3) To avoid passing heavy currents through the moving parts of the ammeter.

How can I recuperate old sal ammoniac batteries? (2) How does a booster operate in connection with storage batteries? E. H. B.

If replenishing the solution does not bring them up, you need either new zincs or porous cups (if the battery is that type) or both. (2) Boosters and storage cells are usually employed in conjunction with compound-wound dynamos which increase the line pressure as the load increases. The arrangement may be such that at no load the booster is idle and the dynamo e.m.f. is sufficiently higher than that of the battery to force the maximum charging current through it; as the load comes on, the dynamo e.m.f. rises and the booster (in series with the battery) commences to supply e.m.f. agreeing with the battery e.m.f.; the booster e.m.f. rises more rapidly than that of the dynamo, so that when the latter reaches full load, the sum of the booster and battery e.m.f's is about equal to that of the dynamo, preventing any current from passing backward through the battery; any increase beyond full-load current increases the booster e.m.f. so as to cause the battery and booster to take the surplus load.

A NEW SINGLE-PHASE RAILWAY SYSTEM.

A most interesting exhibition was given on August 19, on the Ballston extension of the Schenectady (N. Y.) Railway, of a single-phase, alternating-current railway motor equipment built by the General Electric Company. A party of technical journalists attended the trial by courtesy of the General Electric Company, a special car being taken up to Schenectady on one of the New York Central Railroad express trains for the purpose.

The new car equipment possesses the highly advantageous feature of operating on either alternating or direct current, the motors being designed for the standard direct-current voltage (500-600 volts) and step-down transformers being employed to reduce the trolley-line e.m.f. of 2,000 volts to a secondary e.m.f. of 400 volts. The G. E. single-phase motor is a series-wound compensated commutating machine, very similar in outward appearance to the ordinary direct-current railway motor, as Fig. 1 shows. The field magnet, however, is similar in construction to the stator of an induction motor, consisting of a laminated ring with slots all around the interior for the reception of the windings. The latter are distributed, like those of an induction motor, and are arranged almost exactly like the windings of a two-phase motor, one winding giving the main "working" field and the other neutralizing the effect of the armature ampere-turns.

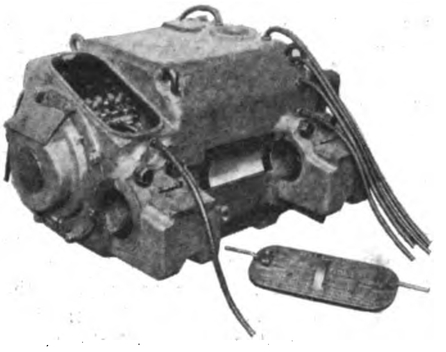

FIG. 1.—SINGLE-PHASE RAILWAY MOTOR.

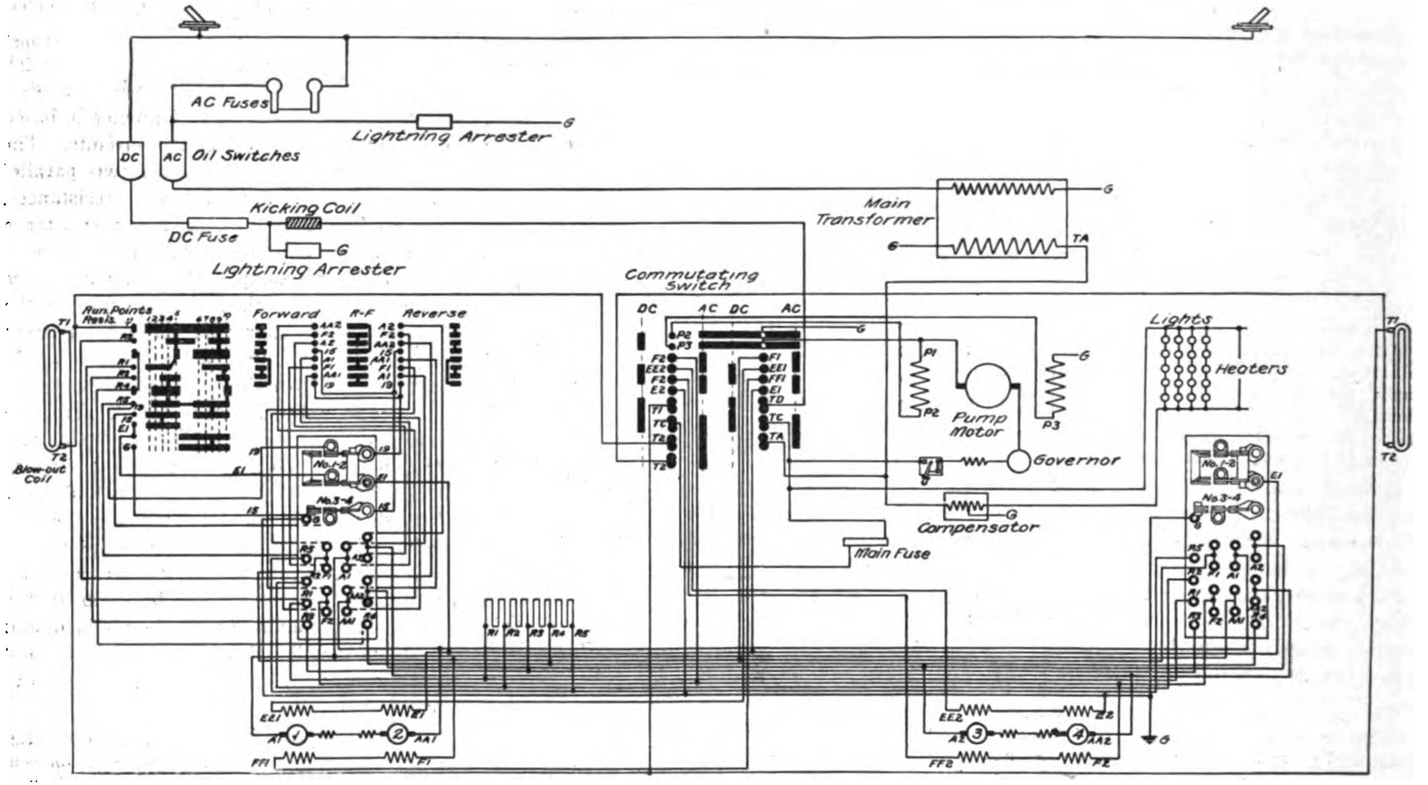

FIG. 2.—CAR WIRING WITH FOUR MOTORS FOR ALTERNATING AND DIRECT-CURRENT OPERATION.

The armature is of the closed-circuit type used in direct-current motors; no auxiliary appliances, such as high-resistance leads to the commutator, being employed to reduce the inductance. In operation on alternating current, the machine sparks slightly at the brushes, but the sparking seems to have no deteriorating effect whatever upon the commutator. On direct current, the operation is absolutely ideal; there is no difference in the appearance of the commutator and brushes from their appearance at standstill. As the accompanying charts show, the motor has about 95 per cent. power factor under normal running conditions on alternating current.

The car equipment exhibited on the occasion referred to above comprised four motors connected up in two pairs, each pair permanently in series; an ordinary direct-current series-parallel controller, a throw-over switch for changing the connections from the direct-current to the alternating current arrangement and an 80-kw. air-blast transformer. The commutating or throw-over switch puts the field windings of each pair of motors in series for operating on alternating current and in parallel for direct-current operation, and also cuts out the transformer in the latter case; otherwise the connections of the machines are identical for both systems. The commutating switch is interlocked with two main oil switches, one being in the high tension alternating current, and the other being in the direct current circuit, this interlocking being so arranged that only one switch can be closed at a time and the commutating switch can only be thrown when the main line oil switches are in the off position.

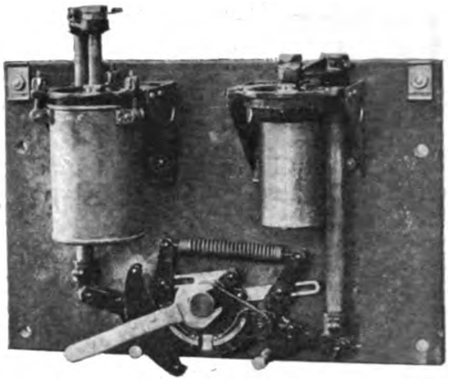

FIG. 3.—OIL-BREAK MAIN LINE SWITCH.

Owing to the fact that the alternating current trolley wire of the Ballston line is off center, while the standard direct-current city and suburban trolleys are directly overhead, it was necessary to provide two sets of trolleys, one for the alternating-current and the other for the direct-current system, hence the necessity for interlocking the oil switches and commutating switch to pre-

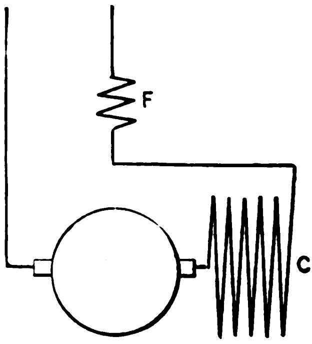

FIG. 4.—DIAGRAMMATIC REPRESENTATION OF CIRCUITS OF COMPENSATED MOTOR.

vent trouble should both trolley poles accidentally be up at the same time. Where center wire construction is used on both the city and suburban sections, the alternating current and direct-current trolley wires may be overlapped for a short distance to facilitate changing from one trolley to the other.

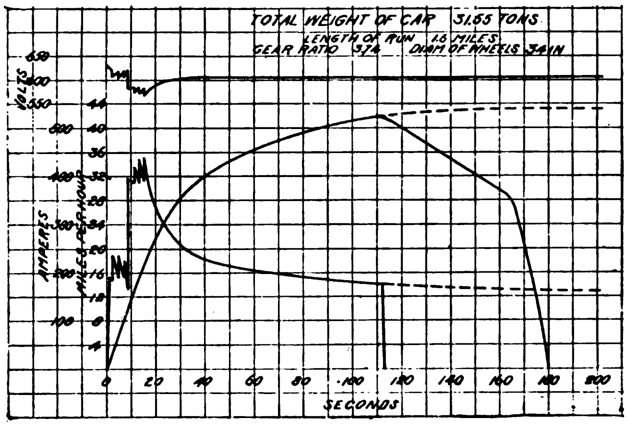

FIG. 5.—OPERATION OF FOUR-MOTOR EQUIPMENT ON DIRECT CURRENT.

With modern suburban cars, especially those equipped with train control, air brakes, air compressors, etc., there is some difficulty in suitably locating the proper apparatus, even when equipped for direct-current running only. With cars equipped for both alternating-current and direct-current running, using series parallel controller, there will be required but slightly more space and weight than for direct-current running only. Should, however, advantage be taken of the slightly better efficiency of alternating current potential control, such cars must be operated alternating current upon both suburban and city sections, with the resulting disadvantages; or the installation of two separate potential methods of control may offer advantages sufficiently great to warrant their adoption.

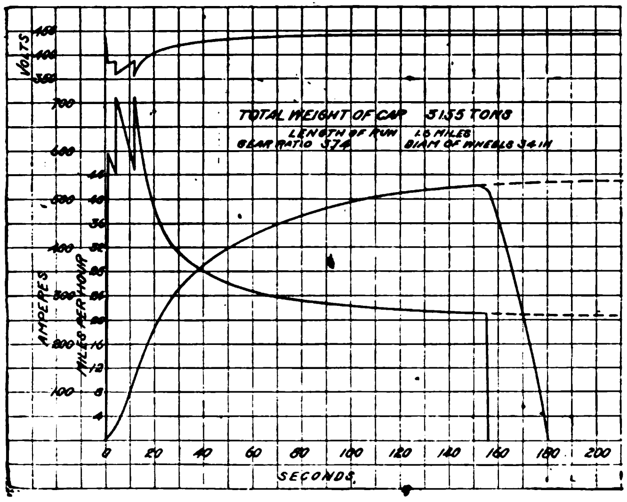

FIG. 6.—OPERATION OF FOUR-MOTOR EQUIPMENT ON ALTERNATING CURRENT.

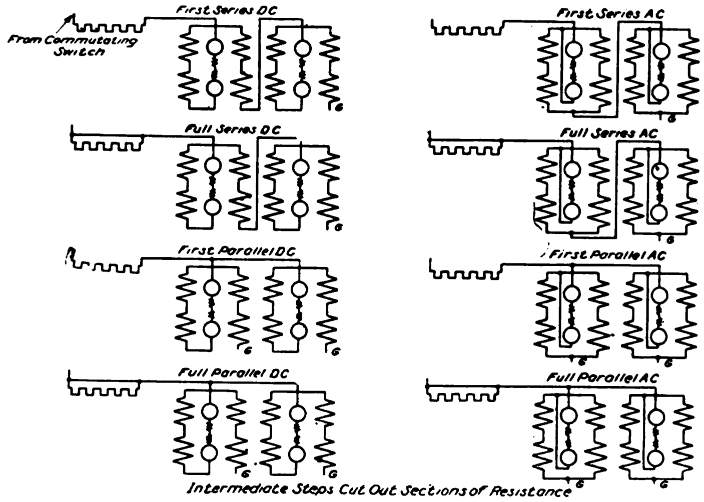

FIG. 7.—CONTROLLER CIRCUITS FOR FOUR-MOTOR EQUIPMENT.

The car equipped with the compensated motors weighs 30.4 tons total, without passengers, and is geared for a maximum speed of 43 miles per hour on the level. It is a Brill car, with a 32-ft. body, or forty-three feet over all, and has a seating capacity of forty-four passengers. The body is mounted upon Brill No. 27 trucks having six-foot wheel base, each truck carrying two compensated motors; each motor is equivalent to a 50-h.p., direct-current motor, standard railway rating.

All speed-time runs taken on the Ballston line were made over a distance of 1.6 miles on tangent level track at an average speed of thirty-two miles per hour, or a schedule speed of 29.5 miles per hour, including fifteen-second stops. The compensated motor equipment has thus demonstrated its ability to make as high schedule speed as any suburban road now operating direct-current equipments under like conditions.

The compensated motors run the car at practically the same speed with 200 volts per motor alternating current and 300 volts direct current. This uniform speed is obtained by series paralleling the field.

Center pole bracket construction is used, there being two brackets supporting the two 600-volt direct-current trolley wires and a crossarm supporting the two 2,200-volt alternating-current trolley wires. The Ballston extension has been operated for several months with direct-current equipments, and their operation being continued in part necessitated an additional set of trolley wires for the alternating-current equipments which would not interfere with the direct-current trolleys. The direct-current trolley conforms to standard bracket construction and presents no unusual features, while the alternating-current trolley wire is suspended from a ⅜-inch steel catenary. The alternating-current trolley is clipped to the catenary midway between poles and the catenary in turn is hung over porcelain insulators on wooden cross arms, the whole forming a construction of great flexibility with the further advantage of providing excellent insulation with standard porcelain insulators and eliminating the span wires adjacent to the trolley wire, thereby preventing the pole catching should the trolley wheel leave the wire. This method of trolley construction is well adapted to high potential, high-speed work in both its electrical and mechanical features.

With the alternating-current system using a trolley and track return, there is an inductive drop in the trolley and rails, with an additional loss in the latter case due to eddy currents and hysteresis. Measurements made upon the Ballston line indicate an apparent trolley resistance of 1.3 times the ohmic resistance, and a rail resistance 6.55 times the ohmic resistance.

Owing to the fact that 25-cycle, three-phase generators are almost universally used to supply rotary converters in existing interurban railway systems, the General Electric Company has adapted the designs of the compensated motor and the alternating-current distributing system to operate from existing 25-cycle generating stations. As the alternating-current motor is single-phase, a single-phase generating and distributing system commends itself on account of its simplicity. The step-down transformers may be tied together on the low-tension side through the trolley, with consequent reduction in amount of copper required. Each sub-station acts as a reserve to the adjacent one and a transformer may be cut out without shutting down a trolley section.

The single-phase alternating compensated motor system is the outcome of years of study and development and is the work of no one person. Mr. William B. Potter, chief engineer of the Railway Department of the General Electric Company, has directed the study and building of the equipment. As the head of the railway department he has personally been responsible for the work. Closely associated with him, an able corps of engineers has been studying the various branches. Mr. A. H. Armstrong has been one of his most valued assistants; another important assistant is Mr. Walter J. Slichter. Prof. Charles P. Steinmetz has given the system considerable study, and his able advice has been of the greatest assistance. Mr. F. E. Case has been interested in the working out of the controllers, and Mr. E. D. Priest has had charge of the perfection of the motors; Mr. Priest in turn has been assisted by Mr. E. H. Anderson.

New Apparatus and Appliances

NEW FORMS OF INCANDESCENT LAMP RECEPTACLES.

The H. T. Paiste Co., of Philadelphia, Pa., manufacturer of the "P-K" receptacles, has recently added two new receptacles to its well-known line of Fielding receptacles. These are designated as "show window receptacles," and are stated to be especially well adapted for display work. They are provided with smaller bases than the regular Fielding receptacles, the straight type shown by Fig. 1 measuring 1½ x 1½ ins. The 60-degree angle receptacle shown by Fig. 2 has a base 2 x 1½ ins. This permits of their being placed much more closely together and enables greater lighting effects to be obtained in a given space. The receptacle shown by Fig. 2 holds the lamp and reflector at an angle that throws all the light upon the articles making up the window display.

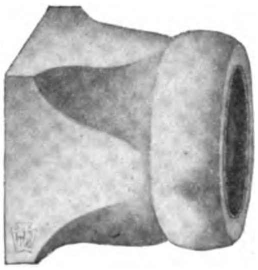
FIG. 1.—SHOW-WINDOW RECEPTACLE.

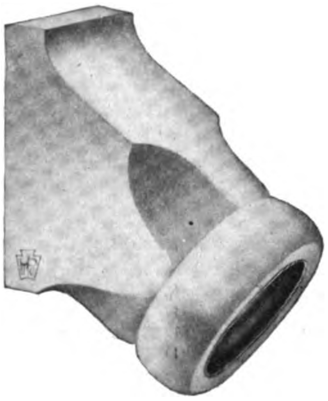
FIG. 2.—SIXTY-DEGREE SHOW-WINDOW RECEPTACLE.

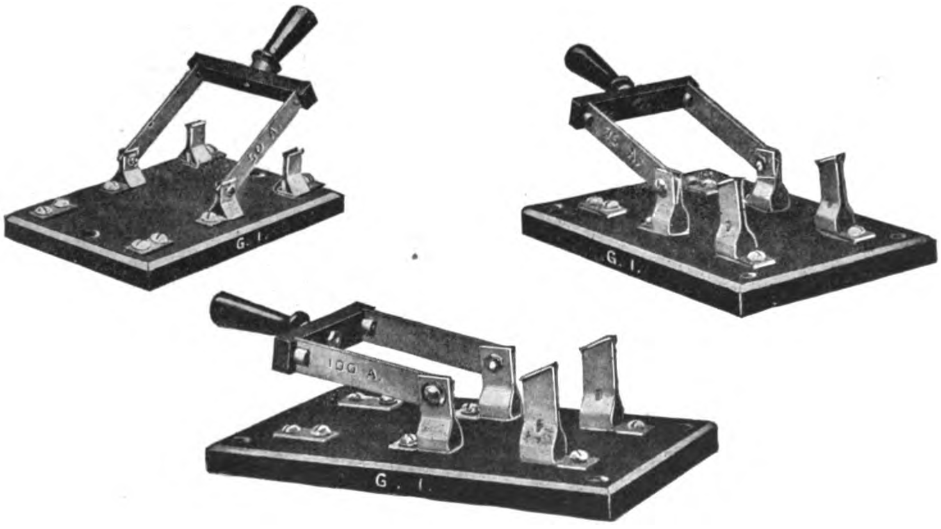
FIG. 3.—PUNCHED CLIP LEVER SWITCHES.

PUNCHED CLIP LEVER SWITCHES.

The General Incandescent Arc Light Company, of New York, has recently brought out a line of lever knife switches designed especially to meet the demand for a cheap, well-made switch for motor or lighting service in factories or similar installations. These are well made, all of the conducting parts being of pure rolled copper, finished by dipping and lacquering on slate bases. The line of switches is made entirely front-connected, lugs but no fuses being furnished in every instance unless otherwise specified. The switches are designed to meet all requirements excepting where highly polished switches are desired. They are furnished in one style of finish in the following sizes: 15, 25, 50, 75, 100 and 150 amperes; 1, 2 and 3-pole, with and without fuses, and single and double-throw, set for 250-volt service.

NEW INSTRUMENTS OF PRECISION.

The Westinghouse Electric & Manufacturing Company has developed a new line of electrical measuring instruments of precision which are said to combine the accuracy of the best known standards with the portability and rapid and easy manipulation of the ordinary testing instruments now in use. The advantages of both types have been retained, it is stated, with the elimination of those features which detract from their value in general use.

The Westinghouse Company further purposes to secure to purchasers a continuation of the initial accuracy of these instruments by keeping them in calibration for five years without charge. Special shipping cases are provided to minimize the labor of packing and shipping. At any time within the period named customers may ship these instruments to the Westinghouse Department of Standards to be checked, and the work will be done promptly, with no cost to the owners except that for transportation.

The illustrations show a voltmeter, an ammeter, a wattmeter and a resistance or multiplier used with a voltmeter or a wattmeter. The voltmeter is exactly similar in appearance to the ammeter, excepting the terminal posts. The mechanism is mounted in a cast-iron frame of a high resistance alloy, and suspended from the top plate. This is made of black enameled slate, giving a rigid construction and not affected by warping or changes in temperature. In principle, these instruments are fundamentally electrodynamometers. The two coils are so arranged as to neutralize the mutual induction and the effect produced by any external field. The readings are thus equally accurate with direct or alternating currents, and there is no necessity for reversing the readings on direct currents, as with ordinary standards.

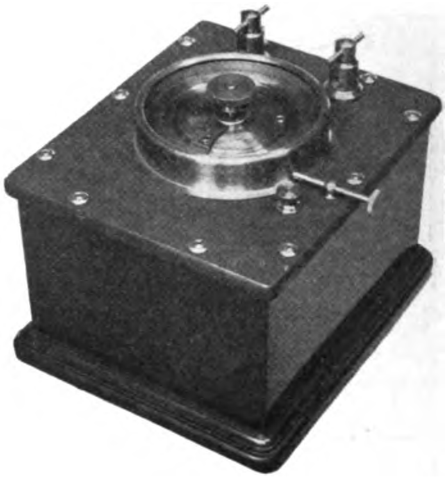
FIG. 4.—AMMETER.

The controlling force is very large, rendering negligible any friction effects, and obviating the disadvantage found in instruments having a controlling force so slight that the static attraction produced by rubbing the glass over the dial will introduce an error. The voltmeter dial here illustrated shows the general form used in the different instruments. The scale is graduated upon a five-inch circle, all the divisions being uniform. By means of a vernier, tenths of a division may be read, giving a range of 20,000 readable divisions.

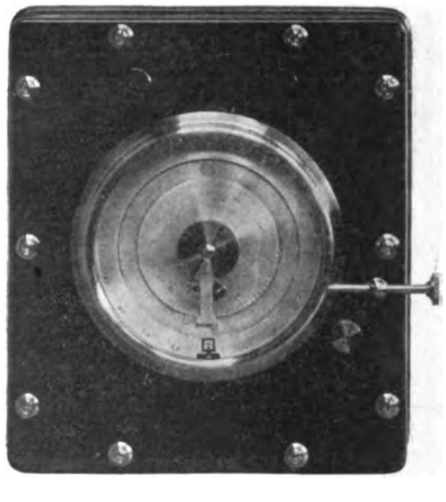
FIG. 5.—VOLTMETER.

The sight wire is shown in a square frame which is attached to the movable coil of the instrument. When current passes through the windings, the sight wire is carried to the right of the zero mark.

By means of the large central knob the vernier is turned to the left until the sight wire is approximately upon zero, a finer adjustment being obtained by the knob upon the right. The voltmeter and ammeter dials are similar. The inner graduations are so spaced that their value is proportional to the square root of the deflection, allowing readings to be taken direct, without calculation. When readings of fractional parts of a division are required, the outside scale with the vernier may be used and the corresponding value of the reading on the inner scale determined from the table of square roots furnished with each instrument. In the wattmeter there is but one set of graduations, similar to those shown on the outer circle of the voltmeter scale. The potential coils of the voltmeter and wattmeter are adjusted to a uniform resistance of 100 ohms, and the external resistance or multiplier is subdivided so as to give total values of 1000 ohms or multiples thereof. A total resistance of 1000 ohms is employed for each 100 volts nominal potential. The resistances are accurately checked, and thus form standards of resistance as well as measuring instruments. As the same values are used for both the voltmeter and the wattmeter potential circuits, one resistance will answer for both instruments. The facilities afforded for accurate observation are worthy of special mention; the fineness of the sight wire, the narrow, even, machine-cut division lines of the scale and the open divisions of uniform length make it easy to take extremely accurate readings at any point on the scale.

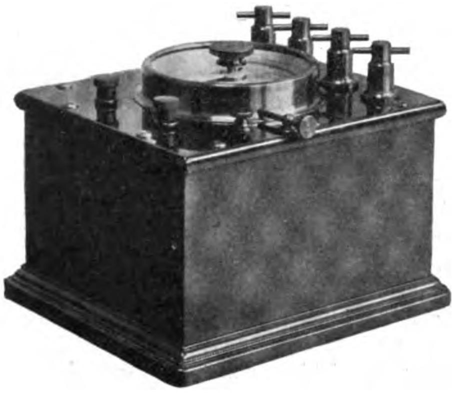

FIG. 6.—WATTMETER.

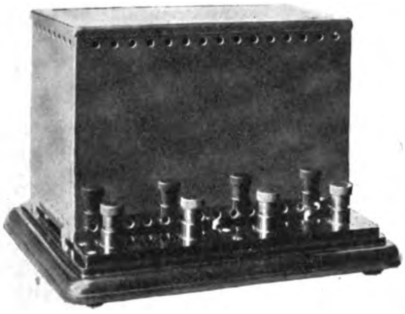

FIG. 7.—RESISTANCE FOR POTENTIAL CIRCUITS.

CLIMAX ENCLOSED ARC LAMP.

The new form of enclosed arc lamp herewith illustrated has been brought out under the name of "Climax" by the Keystone Electric and Manufacturing Company, Allegheny, Pa. Figs. 8, 9 and 10 show it complete and in detail. A special feature shown in Fig. 10 is the regulating coil made by machinery designed for the purpose. A flat copper strip is wound spirally about a solid mica core and each layer of the spiral is separated from the adjacent layer by mica washers. The spiral is then surrounded by another mica tube, and all is encased in a metal tube, with metal heads, to which are fastened the necessary terminals and a clamping device with which to adjust the coil. The whole forms a solid fire-proof coil. Fig. 8 is a view of the mechanical movement of the lamp, with the dash-pot and the flat spiral connectors. The upper carbon holder and the carbon-carrying tube have but one motion and cannot be turned, avoiding disarrangement of the spiral conductor during operation. In the direct-current lamp the dash-pot is constructed with a loose-fitting piston of large diameter in the gas diffusing chamber. The piston is fastened to the clutch plate in such a manner as to have a lateral motion, thus permitting it to find its own free path and avoiding all possibility of wear and sticking due to friction. The enclosing globe cap forms the bottom of the gas-diffusing chamber and dash-pot, and carries the insulating, bushing and negative carbon support. It is held in place by two outwardly swinging arms engaged by two lugs on opposite sides of the gas chamber and fastened by thumb nuts. The clutch is composed of two cast-iron parts—duplicates—hung on two cotter pins in such a manner that when they fall toward each other the opening becomes less than the diameter of the carbon. Hence, when the clutch plate is raised they grip the carbon. The porcelain resistance holder has a thread moulded on its outer surface, in which the wire is wound. A clamping device is placed to one side, with a sliding member, by which the adjustment for proper arc voltage is achieved. The company also furnishes an external resistance, in a separate case, for 220 to 250-volt lamps, which may be placed at any convenient point; or the lamp may be suspended from it. A switch is provided in the top of the lamp. The housing is made of copper and riveted, no solder being used on any part of the lamp. The outside globe holder is fitted to an internal sleeve of the main shell by three bayonet locks, and is easily removed or replaced. Housings of steel or brass can be furnished, if so desired. The inner globe is of large diameter, allowing the whole hand to enter for cleaning. It is of the closed end type, and is readily removed and replaced when trimming.

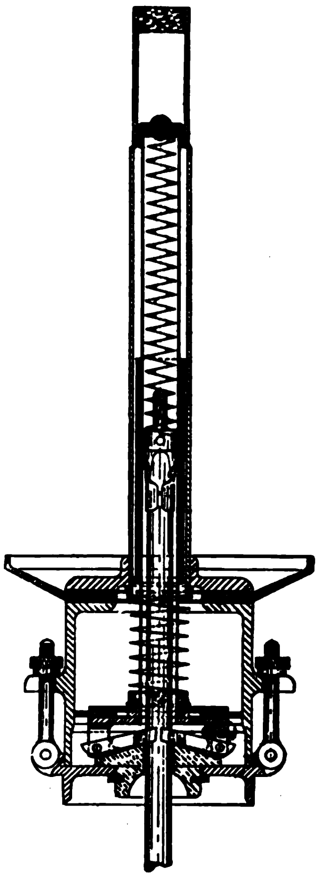

FIG. 8.—DASHPOT MOVEMENT.

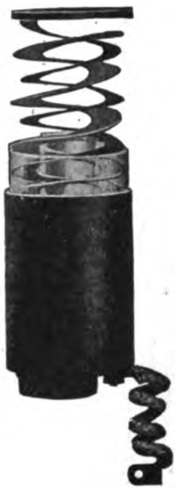

FIG. 10.—REGULATING COIL.

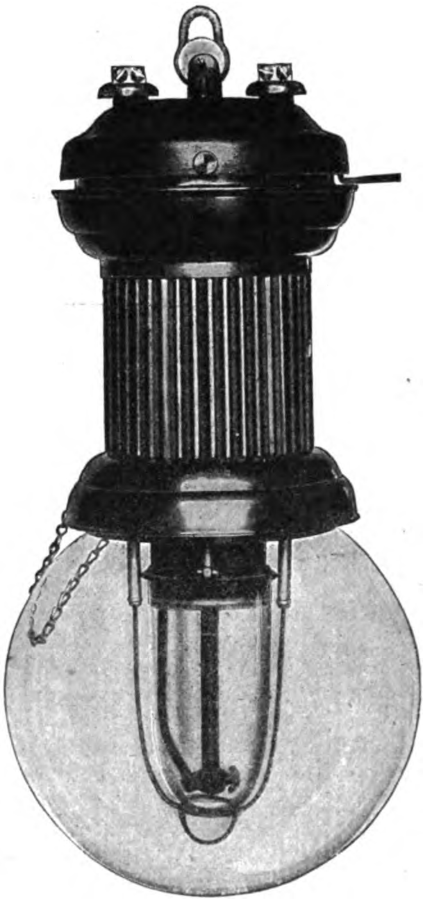

FIG. 9.—ENCLOSED ARC LAMP.

IMPROVED MOTOR-DRIVEN DISC FANS.

Fig. 11 herewith shows an improved disc fan made by the American Blower Company, of Detroit, Mich., direct-connected to a Westinghouse motor. The fan is a modification of the American Company's well-known "A B C" fan, and the motor instead of being attached to the arms of the fan, as has heretofore been customary, is placed upon a substantial base, resulting in a combination of rigidity and compactness. The series-wound, multipolar form of motor is used, except for the very small machines, which are made bipolar. Free ventilation is made possible by the general design. The bearings are self-oiling and the machine requires a minimum of care and attention during operation. The open type of motor shown in Fig. 11 is usually furnished. Enclosed motors may, however, be obtained when conditions require their use. Each motor is furnished with an automatic release switch and a fireproof rheostat.

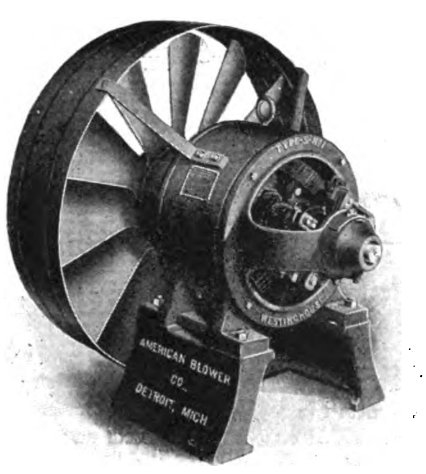

FIG. 11.—MOTOR-DRIVEN DISC FAN.

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CALIFORNIA WATER POWERS AND WATER WHEELS.

Of the many natural advantages furnished by the State of California, not the least is its numerous waterfalls. They are not generally of the spectacular order, as Niagara, although, in the Yosemite Valley and other parts of the State, one may find some waterfalls which rival in grandeur that famous sight. Hundreds of miles of pipe lines traverse the State and make possible the utilization of water under pressures heretofore unheard of in actual practice. As an instance may be cited the plant of the Edison Electric Company near Redlands, in the Southern part of the State, where a Pelton water wheel is operating under a head of 1950 feet—equivalent to 850 lbs. pressure per square inch. This wheel is direct-coupled to an alternator and has 1000 horse-power capacity. The station is only one of many controlled by this company, which has a large number of Pelton wheels in use under heads ranging from 100 feet up to the figure just named—1950 feet. It is interesting to note that under such extreme pressures the water issuing from the nozzle is so dense that a sledge hammer will have no effect upon it; this has been demonstrated by actual experiment. Obviously, the nicest mechanical workmanship and design are required to construct a wheel to withstand such severe conditions. The demands for cheap power, together with the advantages of water at hand, have naturally led to the development of a water wheel to supply the connecting link, and it was a pioneer Californian, L. A. Pelton, who first conceived the idea of a water wheel to operate under high heads. In the "days of '49" the Pelton wheel was called the "Hurdy-Gurdy" wheel, and consisted of a wooden rim, to which were bolted cast-iron "buckets," as they are technically called. Later on the fundamental patents were acquired by The Pelton Water Wheel Company, of San Francisco, who, by experiment, further developed the original idea—of course, making radical changes in design and construction—and succeeded in producing a wheel from which remarkable results are obtained. An efficiency of 90 per cent. has been reached by this wheel in tests which, however, were made on wheels operating under the most favorable conditions; but efficiencies of 80 and 85 per cent. are said to be realized in ordinary practice.

The Pelton Water Wheel Company has built up a large industry in the manufacture of water wheels. In the last sixteen years there have been installed over 11,000 Pelton wheels, aggregating over 1,000,000 horse-power, and ranging from a fraction of a horse-power up to 10,000 horse-power per wheel unit. It is interesting to note that one may find this California machinery product in use driving fans in a bungalow in India as well as operating a 30,000-h.p. electric plant in Oregon.

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NEW BOOKS.

BEGINNER'S MANUAL OF SUBMARINE CABLE TESTING AND WORKING. By G. M. Baines. Second Edition. London: *The Electrician* Printing & Publishing Co., Ltd. New York: D. Van Nostrand Company. 217 pages, 8½ ins. x 5¼ ins. Price, $3.50.

This book bears no date, either on the title page or at the end of the preface, which omission is frequent with books published of late years, especially by the London publishers of this work. This is a pity, for the omission of a date actually depreciates the value of any book, but more particularly a technical book pertaining to a subject in which rapid progress is being made.

As is indicated by the title, this book is for beginners, the treatment of the subject being somewhat more elementary than that of the "Student's Guide to Submarine Cable Testing," by Fisher and Darby, brought out by the same publishers. It is, nevertheless, a very good book, within its chosen field, giving satisfactory accounts of many tests; the description of the Ayrton and Mather or "universal" shunt might, however, be clearer. It seems as though the principles of this shunt might be expounded in a manner that is not only lucid but luminous, using only language adapted to a work like the present one, intended for beginners; yet the reviewer has never seen an exposition that was entirely satisfactory.

Mance's method for measuring the internal resistance of a battery by means of a Wheatstone bridge is another matter that is not usually treated with sufficient perspicuity; in this book, the treatment is perfunctory or even slovenly; there is no intelligible explanation of the rationale of the method. The reviewer remembers the difficulty he had, when a student, in understanding Mance's method, although the ordinary Wheatstone bridge and Kelvin's method for the resistance of a galvanometer were perfectly clear. It is possible, however, to make Mance's method clear by a brief explanation. Schaffer's test for locating a break is treated somewhat fully, the author preferring it to Mance's or Kennelly's tests. This test is not described in Fisher and Darby, and not so well handled in some other books. All the more important tests used in cable work are treated in the book under review, some of them in a very satisfactory manner—a manner adapted to the requirements of the class of readers for whom the book was written.

ELECTRIC MOTORS. By H. M. Hobart. New York: The Macmillan Company. 1904. Cloth; 458 + X pages, 5½ ins. x 8½ ins.; 480 illustrations. Price, $5.

One of the peculiarities of all textbooks on the principles of dynamo design or construction or both is the lack of adequate information regarding motors; the present volume, therefore, is amply justified, and, as might have been expected by reason of the author's high standing as a designer, it represents a very efficient effort to supply the deficit in its class of literature. That the book does not cover the subject with absolute completeness is undeniably true, but it does cover a tremendous scope and is of the highest merit as far as it goes. Among the many "points" in motor design which are never discussed in books on dynamo design and are thoroughly covered in the work under review may be mentioned the relation between brush position and speed regulation (p. 7), precautions to be taken in designing an open motor so that it may have as high a rating as possible when enclosed (pp. 13-15), stray losses in commutation (pp. 34-36), and the analysis of a design with relation to the cost of construction (pp. 108-111).

A drawback in the author's method of treatment is his apparent aversion to formulas and definite or specific advice; here and there throughout the book one is also hampered by empirical statements without any explanation of their basis. Thus, in Chapter III, Fig. 16 shows the corrected magnetic density in armature teeth for three values of the ratio of slot width to tooth width and for a certain quality of steel, but the formula by which the chart is calculated is not given, and the chart is worthless for any considerable different width ratios or steel qualities. On page 25 the author allows 20 per cent. increase in the number of active teeth per pole, over the number actually under the pole, for fringing, but does not state why this proportion is chosen; nor does he say why 10 per cent is taken as the increase due to spreading in considering the 35-h.p. design on page 177. On page 33 he says: "There have now been set forth not only methods for calculating all the magnetic circuit proportions, but also all the component losses which determine the efficiency at various loads; the reviewer is unable to find any justification for this statement. Illustrations of the calculation of the magnetic circuit, etc., are given, but these involve empirical practice which is not explained, nor are any formulas or data given which would enable one to follow the author's method in designing machines differing widely from those used as illustrations. The explanation of the author's method of computing reactance voltage of a short-circuited coil is very clear, but it should have been summed up in the shape of a formula. No intimation is given as to whether the reactance voltage should be restricted to 2 volts or allowed to reach 10 volts or some other figure, beyond the fact that it does not exceed 4.4 volts in any of the described designs and is below 3 in most of them. "A wide interpolar space and low reactance voltage" are recommended, but the author gives no idea as to his definition of "wide" and "low." But what *is* said is extremely meritorious and helpful. The examples of motor design are valuable, and the author's illustration of the working out of a 35-h.p. design, Chapter X, is particularly fine. The discussion of variable speed motors, in Chapter XI, is also good.

The second half of the book is devoted to alternating-current motors, and the treatment of induction-motor design is eminently practical, although open to the same criticism as his treatment of the direct-current machine, *i. e.*, there are not enough formulas and definite advisory statements.

In conclusion the reviewer wishes to emphasize the fact that the foregoing criticism is offered with the most friendly intentions and not with the slightest desire to find fault in a carping spirit. The book is far and away ahead of anything thus far published in English on the subject.

SOME EXHIBITS AT THE ST. LOUIS EXPOSITION.

NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., has installed a 1500-kw., alternating-current generator in the exhibitors' power plant. A description of this alternator was given in the May number of THE AMERICAN ELECTRICIAN. In the company's exhibit in Electricity Building an opportunity is given to study the features of construction of this company's electrical machinery. A 400-kw., direct-current generator is shown, which is representative of the company's direct-current construction for the larger units. This has pole tips of soft laminated iron which are bolted to cast field cores and serve to hold the field coils in place. Considerable space is allowed between the series and shunt coils of the fields, so that air can circulate between the coils and permit them to be run at a higher current density without overheating. The armature coils are formed from copper strips or bars, but there is no riveted or soldered joint at the end opposite the commutator. The form of coil has been adopted which permits the bars to be bent hot and afterward insulated so that no soldering is necessary in the entire coil save where it connects to the commutator bars.

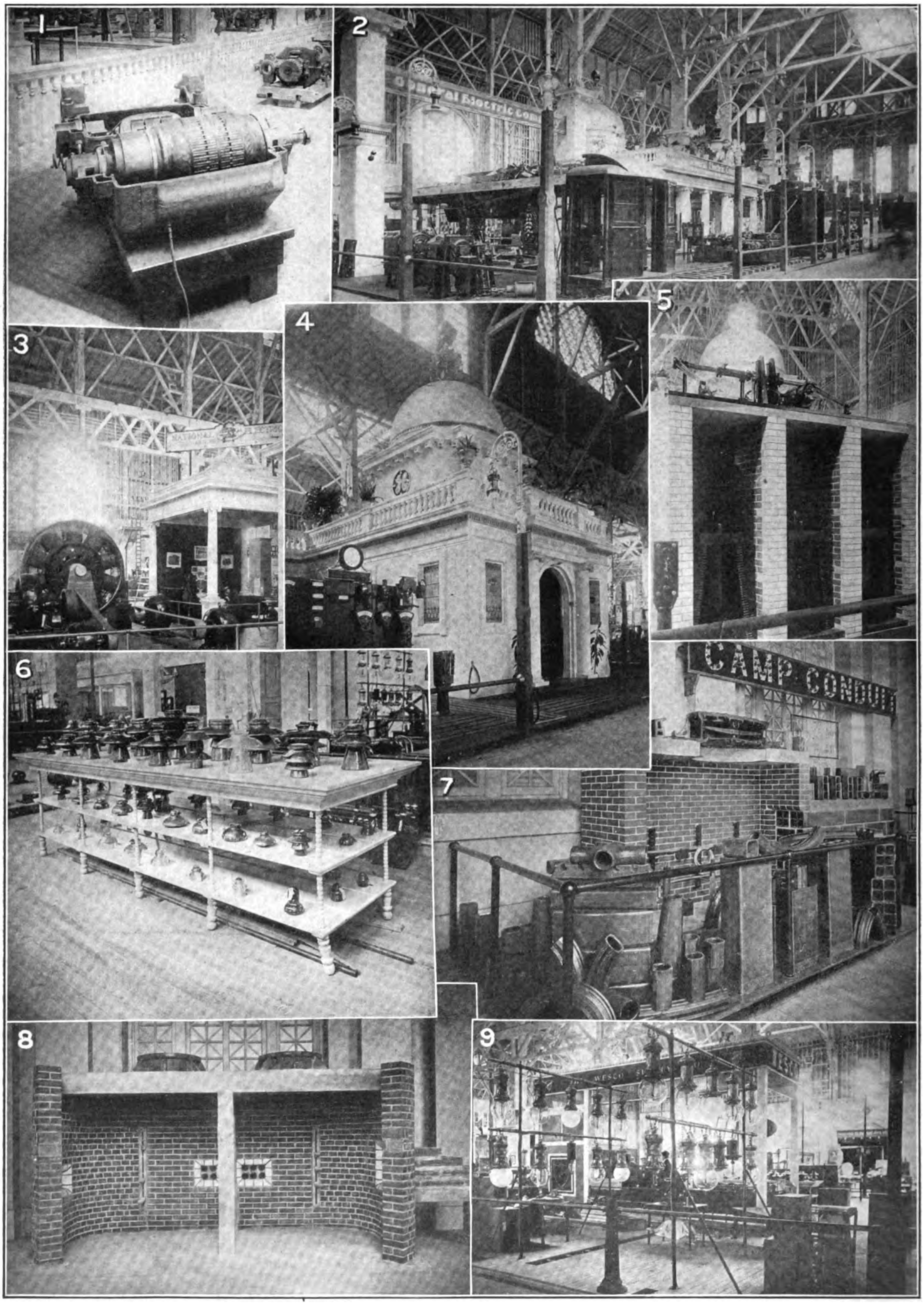
LOCKE INSULATOR MANUFACTURING COMPANY, Victor, N. Y., has a display of high-tension insulators in the exhibit of the Wesco Supply Company, of St. Louis. These insulators are of all sizes, from the smallest telephone insulators to one of 17 inches in diameter and 15 inches high. The latter insulator is designed for working voltages of 80,000 volts and consists of an umbrella-shaped porcelain top surmounting three porcelain petticoats which prevent discharges to the pin.

G. M. GEST, conduit contractor of Cincinnati and New York, has a handsome sample of underground conduit construction work in the court of Electricity Palace. This consists of one-half of a manhole with the tiled cable ducts leading from it. Cable hangers are placed in metal slots imbedded in the brickwork. This hanger, which forms one of the specialties of Mr. Gest, can be put at any height and only the hooks actually in use need be put in place.

H. B. CAMP CO. has an exhibit of conduit ducts in the court of Electricity Palace. One-half of a manhole is shown with a Camp multiple-duct conduit entering it. Besides this, many samples of different duct sections made by the company are shown, including the Camp divided-tile conduit, which can be used either as an unbroken tile or can be split open. Several kinds of bends and straight-line conduit are included in the exhibit.

THE WESCO SUPPLY COMPANY, St. Louis, occupies an area of 5,300 square feet. This contains a number of exhibits furnished by the several large manufacturing companies whom the company represents. One portion of the space is devoted especially to electric railway goods. The Globe Electric Manufacturing Company, of Cleveland, Ohio, has several of its arc and incandescent headlights on exhibition.

THE ALLIS-CHALMERS-BULLOCK 5000-h.p. engine and generator in section 36 of Machinery Building is generally admitted to be one of the most notable and attractive exhibits in the Exposition. The unit was installed not only as an exhibit, but plays an important part in furnishing power for the decorative lighting and for the street railway lines leading to the Exposition Grounds. During the daytime, from 2 in the afternoon until 7 in the evening, current is supplied to the St. Louis Traction Company, the load being about 3,000 horse-power. In the evening the unit carries the current for nearly 200,000 8-c.p. incandescent lamps which are gradually brought from darkness to full brilliancy. At one corner of the exhibit is a large, square cage filled with gridiron-shaped pieces of metal which form the rheostat, the purpose of which is to absorb the current created by the exciter for the generator of the big engine and regulate it until wanted. On the face is an arm which revolves over a large number of contacts. As this makes a turn it cuts out little by little the resistance of the rheostat. This arm is turned by means of a small electric motor on top of the cage. When the time for lighting arrives an operator at the main switchboard touches a button and the little motor begins to move. As the resistance of the rheostat is gradually cut out the whole number of decorative lights over the entire fair begin to glow and gradually gain in volume of light as the arm progresses about the circle. The engine is of the style designed by the Allis-Chalmers Co. for the Manhattan power station in New York. It is capable when worked to its full capacity of producing 8000 horse-power. It is a combined vertical and horizontal compound condensing engine running at 75 r.p.m. under a steam pressure of 150 pounds. The height of the engine above the foundation is 39 ft. 2 ins. Other details are a follows: High-pressure cylinder, horizontal; valves in cylinder; valves and cylinder double ported. Diameter, 44 ins. Low-pressure cylinder, vertical; side-pipe construction; valves in heads; valves double ported; heads single ported. Diameter, 94 ins. Piston rods, high pressure, 9 ins. in diameter; low pressure, 10 ins. in diameter. Steam ports, high pressure, area 150 sq. ins.; low pressure, area 712 sq. ins. Exhaust ports, high pressure, area 206 sq. ins.; low pressure, area 930 sq. ins. Stroke, 60 ins. Shaft, hollow, forged open hearth steel. Diameter, 37 ins. in wheel and generator fits, 34 ins. in main bearing, 32 ins. in outer bearing, 30 ins. in crank hub; hollow, 16-in. hole. Main bearing, 30 x 60 ins.; ball-and-socket type. Outer bearing, 32 x 48 ins.; ball-and-socket type. Crank, fan-tail type, cast steel. Crank pin, nickel steel, 20 ins. diameter, 18 ins. long; common to both high and low-pressure engines. Fly wheel, 25 ft. in diameter; rim, 30 ins. face, 33 ins. deep, built in 10 segments. The whole engine weighs 720 tons; fly wheel, 300,000 lbs.; shaft, 61,000 lbs.; crank, 32,000 lbs., and the total revolving parts, including generator, 514,400 lbs. An Alberger bar-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CAMP CONDUIT
General Electric Co.
WESCO

A GROUP OF EXHIBITS AT ST. LOUIS.

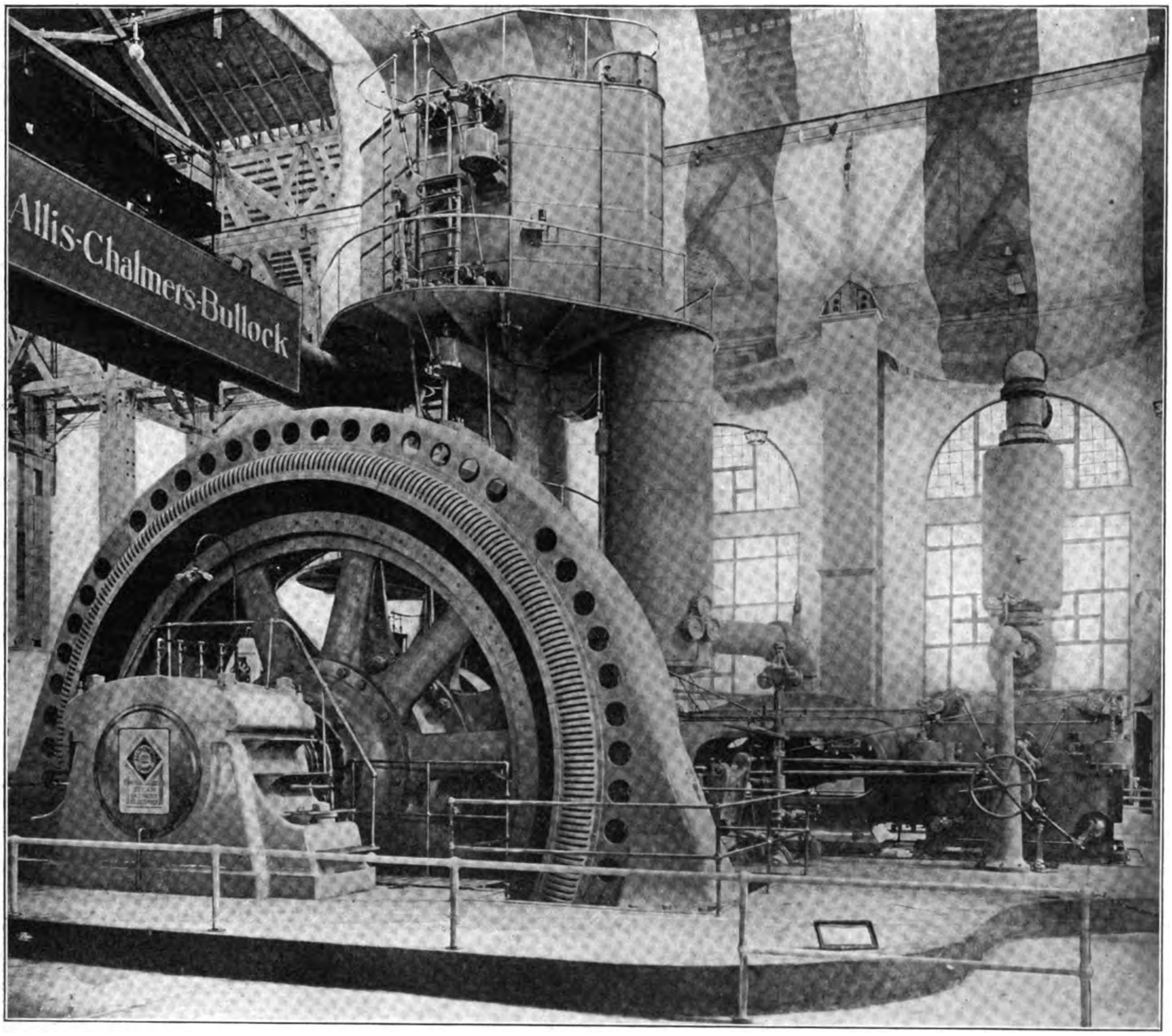
1. **Bullock Railway Motor.** 2. **General Electric Company.** 3. **National Electric** Company. 4. General Electric Company. 5. **General Electric Oil Switch.** 6. **Locke** Insulator Manufacturing Company. 7. **H. B. Camp Company.** 8. G. M. Gest. 9. The Wesco Supply Company.

ometric type condenser is used and the exhaust pipe is 36 ins. in diameter. The regulator of the engine is of the center-weight fly-ball type and actuates a cut-off cam on both the high and low-pressure cylinders. Mounted on the regular cross-shaft is a device for changing the cut-off on the low-pressure cylinder by hand, independent of the high-pressure cylinder. It is also possible to vary the ratio of cut-off between the two cylinders by means of a hand-wheel adjustment on an arm transmitting motion regulated to the low-pressure cam. By these arrangements it is possible to maintain a proper receiver pressure under all possible conditions that may arise in the operation of a larger power unit. The speed of the engine can be increased or decreased several revolutions per minute. This is accomplished by an adjustable weight mounted in a yoke on regulator cross-shaft. By moving this weight in either direction from its central position, which is neutral, the effect is equivalent to increasing or decreasing the center-weight of the regulator. An electric synchronizing device is attached, to be used while operating the generator in multiple with others. A small reversible electric motor is mounted upon the regulator column in a manner similar to the hand speed-changing device previously described. This motor is operated from the main switchboard by means of a double-throw switch. The motor itself forms the weight for varying the speed, and is made to travel in a frame by means of gears and a threaded spindle. When it is desired to get the generator "in step" with others in operation, the switchboard operator can instantly bring the machine to synchronism by means of the switch controlling motor on regulator. An ingenious but simple arrangement is provided to prevent damage to motor or its attachments, if at any time it should be allowed to run to either extreme of its travel. The gear turning on the threaded spindle engages the latter through a clutch, causing the spindle and gear to revolve together, thus preventing the motor from advancing in its mounting, though it may still continue to run. This obviates the use of cut-out switches on the motor, and the only interruption in the motor circuit is the switch on the main board.

The regulator is equipped with belt-rider safety-stop. This acts on the high pressure cut-off cams and prevents the steam valve from opening.

An oil dashpot is attached to the column of regulator, to prevent "hunting" effects while the engine is operating under variable loads. The piston of this dashpot is turned spherical on its face, thus obviating the possibility of bending action between it and bore of pot.

An important feature is a 2-in. by-pass by which live steam can be admitted directly to the receiver of the low pressure cylinder without first passing through the high pressure cylinder. This makes it impossible for the engine to stop on a dead center, for if the high pressure connection rod were at center the low pressure rod would be at right angles to it, and to start the engine



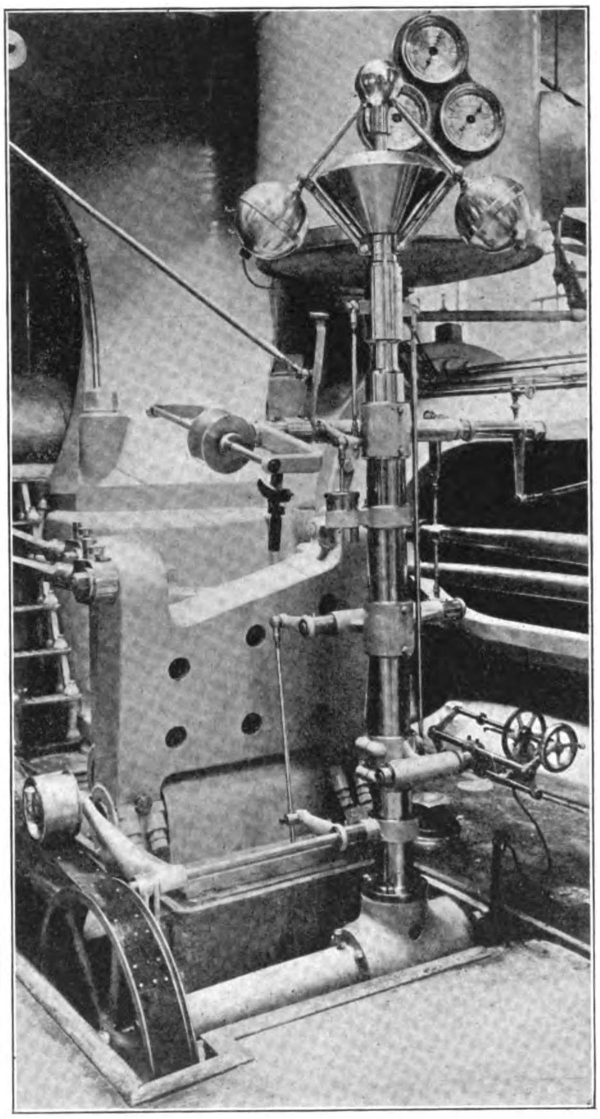
THE ALLIS-CHALMERS-BULLOCK UNIT.

it would only be necessary to open the by-pass valve a little and let steam into the low pressure cylinder. The by-pass has other valuable uses which every practical engineer will appreciate. It is controlled by a valve which is moved by means of a small wheel on a low upright which stands close to the foot of the standard of the throttle operating wheel.

The generator is a 3500-kw. engine type alternator, generating three-phase current at 6600 volts, 25 cycle, and running at 75 r.p.m. It was built by the Bullock Electric Manufacturing Company, of Cincinnati, Ohio.

In the design of this generator have been embodied the most modern practice and engineering skill and many improvements have been introduced. The stator yoke is cast in four sections, securely fastened together by body-bound bolts and held in proper alignment by square splines. These bolts are on the inside of the yoke and give to this machine a graceful and pleasing outline. The casting is cored so as to admit an abundance of fresh air for ventilation through the centrifugal action of the rotor when in motion. The yoke is 27 ft. in diameter, the over-all dimensions being 33 ft. and the casting alone weighing 58,000 lbs. The stator core is built up of mild annealed steel discs 14 mils thick, which are carefully japanned to reduce the eddy currents and again annealed after punching. The dies and punches used to make these laminations are of the modern construction, entirely eliminating the burrs on the outside of the punchings, and therefore no filing is necessary in the slots, which greatly reduces the iron losses. The punchings are rigidly held together by bolts and at frequent intervals are separated by brass castings producing wide air ducts which afford ample ventilation. The pole pieces, of which there are forty, are also built up of laminated annealed steel and held together by malleable iron end plates secured with rivets. The magnetizing coils of the field are made of strip copper wound on edge.

The motor is composed of ten cast-iron arms, securely fastened by heavy cast-iron flanges bolted together. The top of these arms is built up with 1-16-inch punchings, forming a core which is ventilated by two brass spacers each 1¼ inch wide. This core is dovetailed to receive the poles, which are secured by wedge-shaped steel keys. The collector rings are 51 ins. in diameter and are made of copper having liberally proportioned brush surface and separated by a large air space providing ample insulation. The brushholders are of the box construction, carbon brushes being used.



GOVERNOR OF ALLIS-CHALMERS ENGINE.

PERSONAL.

MR. GEO. G. KING has been appointed manager of the Youngstown (Ohio) Telephone Company, succeeding Mr. W. F. Crossley, who resigned the position to accept the State managership of the Colorado Telephone Company.

MR. J. R. BIBBINS, of the Westinghouse Machine Company's staff, read an extremely interesting paper recently before the New England Railroad Club on "The Fitness of the Steam Turbine for Heavy Power Service." The paper has been reprinted in pamphlet form by the Westinghouse Company.

MR. E. W. RICE, JR., the well-known managing director of the General Electric Company, is the subject of a very complete biographical sketch in the August number of Cassier's Magazine. The sketch is naturally highly complimentary to Mr. Rice; it could not be otherwise without inaccuracy.

MR. ED. L. NASH, who has been Eastern sales manager of the Jandus Electric Company for many years, has severed his connection with that concern to accept the managership of the Philadelphia office of the General Incandescent Arc Light Company. Mr. Nash's headquarters are in suite 1208-1209 North American Building.

MR. J. P. GREENWOOD has moved his headquarters from Hattiesburg, Miss., to New Orleans, where he has opened an office in the Hibernia Building. Mr. Greenwood is now district manager for the Electric Machinery Company of Minneapolis, and is also Southern agent for the Reeves Engine Company of Trenton, N. J.

MR. JAMES W. LYONS, formerly manager of the Allis-Chalmers Company's power department, resigned that position last month to accept the appointment of consulting engineer to the Elgin Watch Company, which will erect extensive new works under his supervision. Mr. Lyons' headquarters will be in Chicago, and he will engage in other consulting engineering.

MR. HAROLD R. WELLMAN, for the past five years chief engineer of the motor department of the General Incandescent Arc Light Company, has joined the engineering staff of the Western Electric Company, at Chicago. Mr. Wellman displayed a high degree of ability as a designer of motors of small and moderate sizes while with the G. I. Company, and the Western Electric Company is to be congratulated upon his addition to its staff.

MR. E. R. CARICHOFF, the well-known electrical engineer and expert in electric elevator work, has established an office at 20 Broad Street, New York, and will engage in consulting engineering. Naturally, Mr. Carichoff will make a specialty of electric elevators and motor control, his long experience with the Otis, Sprague and General Electric companies having especially qualified him for these branches. He will also make examinations of inventions and patents.

MR. ROSCOE CORNELL has been appointed manager of the branch office which the Allis-Chalmers Company has just opened in El Paso, Texas. Mr. Cornell goes to the Allis-Chalmers Company from the Mine & Smelter Supply Company, of Denver. He is a graduate of the Michigan College of Mines, and is well known as a mining and mechanical engineer. He has held a number of prominent positions as a mining engineer, and as a smelter and mine superintendent. His acquaintance is extensive, and he is thoroughly qualified to fill the important position to which he has just been appointed.

MR. J. H. HALLBERG, the arc-lighting specialist, has been retained as consulting engineer by the Atlantic Mills, Providence, R. I., where extensive developments are under way. This mill already operates something like 1000 arc lamps, about 1000 incandescent lamps and several hundred horse-power in direct-current motors, and there has now been erected a new power plant containing a 600-h.p. Westinghouse steam turbine, direct-connected to a two-phase, 440-volt, 60-cycle generator, which will furnish power for a number of motors installed in one of the mill buildings. Since Mr. Hallberg has had charge of this plant his recommendations and suggestions, we understand, have been the means of reducing the operation expenses of the present equipment to a considerable extent. Mr. Hallberg is now looking into the matter of electric drive for the various mill machinery in this plant, which will probably require and ultimate electrical equipment of 4000 horse-power.

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TRADE PUBLICATIONS.

SMALL DYNAMOS AND MOTORS. Eck Dynamo & Motor Works, Belleville. N. J.—Bulletins 34 and 35, the former containing descriptive material and the latter price-lists of the excellent small machines built by this concern.

BOOKS FOR HOME STUDY. Frederick J. Drake & Co., Chicago.—A catalogue of which the title is partly descriptive. The books listed therein cover almost every subject imaginable from hypnotism to electrical engineering.

AUTOMATIC CIRCUIT-BREAKERS. Ward Leonard Electric Company, Bronxville, N. Y.—Catalogue No. 19,043, in "loose-leaf" pamphlet form, containing illustrations and price-lists of the very complete line of circuit-breakers made by this company.

STERLING BLACK PLASTIC INSULATOR. The Sterling Varnish Company, Pittsburg, Pa.—A series of cards on each of which is presented, concisely but effectively, a strong argument for this new insulating material. A sample of the material is attached to each of the cards.

POLYPHASE REVOLVING-FIELD ALTERNATORS. Fort Wayne Electric Works.—Bulletin No. 1057, containing an illustrated description of the revolving-field belt-driven alternators of this company.

SARGENT AND COCKERILL GAS ENGINES. The Wellman-Seaver-Morgan Company, Cleveland, Ohio.—Two finely-executed books, one containing a brief but well-illustrated description of the Sargent engine and the other a similar description of the Cockerill engine.

SECOND-HAND MACHINERY READY FOR DELIVERY. Joseph H. Thompson, Jr., New York.—This is Bargain List No. 2, consisting of a small pamphlet in which is listed a considerable quantity of steam and electrical machinery and apparatus that has been put in "good-as-new" condition and is ready for immediate delivery.

BULLOCK APPARATUS AT ST. LOUIS. The Bullock Electric Mfg. Company, Cincinnati.—A handsome pamphlet containing illustrations of the Bullock generators, transformers, motors and controllers that have been installed in the Bullock exhibit and elsewhere in the Exposition grounds.

SOCIAL ECONOMICS OF THE WESTON ELECTRICAL INSTRUMENT COMPANY. Weston E. I. Company, Newark, N. J.—This is a beautifully-executed book in which are described very fully arrangements at the Weston Works for the comfort of the employes. It makes most interesting reading.

TESTS OF CENTRIFUGAL PUMPS. De Laval Steam Turbine Company, Trenton, N. J.—Bulletin No. 9, containing a copy of the report of tests made by Profs. Wm. Kent and J. E. Denton of two De Laval centrifugal pumps driven by De Laval steam turbines and one centrifugal pump driven by an electric motor. The results of the tests are presented in full and are extremely interesting.

BOOK OF THE FOUR POWERS. Allis-Chalmers Company, Chicago.—This is a superb specimen of trade literature, as to its execution. It is a handsomely-illustrated book presenting a summary of the scope of the Allis-Chalmers Company's activity. The "Four Powers" are Steam, Gas, Water and Electricity, and the book tells the story in a most interesting style.

AUTOMOBILE SUPPLIES. Electric Appliance Company, Chicago.—This is Catalogue No. 23, of standard size, containing illustrations and prices of spark coils, ignition batteries, electric "flash" lights, gas engine igniter dynamos, spark plugs and numerous other appliances and material which are required to complete the outfits of gasoline and electric motor vehicles.

SUNBURST LAMPS. The Sunbeam Incandescent Lamp Company, Chicago and New York.—This is Catalogue No. 10, containing profusely illustrated descriptions of the line of Sunburst incandescent lamps. The lamps have spherical bulbs, frosted all over except for a small part near the base, and the clear portion is covered by a reflector when the lamp is in the socket. The book is very tastefully executed.

MEYER-GEAR PUMPING ENGINES. Laidlaw-Dunn-Gordon Company, New York.—This is Bulletin L-601 in which are described and illustrated Meyer-gear pumping engines for small water-works and elevator service. They are built in cross-compound and three-cylinder compound types and are said to show a steam consumption of little more than one-half that of the best direct-acting compound steam pumps.

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BUSINESS NEWS.

BROWN CORLISS ENGINE COMPANY, Corliss, Wis., has been awarded the contract for four large vertical cross-compound engines, to be direct-connected to generators at the Washington Navy Yard.

FEDERAL ELECTRIC COMPANY has removed its offices and factory to Girard, Pa., where modern facilities and additional shop equipment will enable the company to increase its output and facilitate the prompt and efficient handling of orders.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, of New York, furnished the Frank Adams Electric Company, of St. Louis, with all of the oil switches for the distribution of high-tension current in the various buildings of the St. Louis Exhibition. The order was of considerable magnitude.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, 529 W. 34th St., New York, have been awarded the contract for a large quantity of G. I. arc lamps (110 volts D. C.) for John Wanamaker's new New York store, after very severe competition between the most prominent arc lamp manufacturers.

THE KNICKERBOCKER CONSTRUCTION COMPANY, New York, has been awarded the contract for the installation of the underground and aerial cables for the new Lewiston-Auburn (Maine) Automatic Telephone Company, amounting to over 100,000 feet. The cable is being manufactured by the Stromberg-Carlson Telephone Manufacturing Company, at its Rochester (N. Y.) factory.

THE LOCKE INSULATOR MFG. COMPANY, Victor, N. Y., with an eye to further increase in the voltages for insulator tests, and also to facilitate the systematic study of insulating problems, recently installed a 300,000-volt transformer of 200 kilowatts capacity, the primary of which will be supplied with current from a motor-generator set connected with a neighboring transmission line.

THE B. F. STURTEVANT COMPANY, Hyde Park, Mass., is fitting up quarters in its big plant to be used for an emergency hospital in case of accident to employes. It is to be equipped with all the appliances known to medical and surgical science for the proper care of men who may get injured in the discharge of their duties until they can be removed to their homes. A graduate nurse and medical student will be in charge and a local doctor will attend to all surgical cases.

THE SPRAGUE ELECTRIC COMPANY, New York, which has for many years been identified with the manufacture and installation of electric motors for operating ventilating fans and blowers, reports among recent installations motors driving the ventilating apparatus in the Chicago Post Office and the New York and Brooklyn public baths. In the West 41st Street and East 76th Street public bath there will also be installed two 30 and two 25-kw. Sprague engine-type generators.

THE NATIONAL ELECTRIC COMPANY, successor to the Christensen Engineering Company, Milwaukee, manufacturer of Christensen air brakes and electrical machinery, has just completed extensions of its foundries, and is soliciting orders for open hearth, crucible steel, semi-steel, iron and brass castings. The foundries are equipped with every facility for rapid and economical output, and as the nature of the company's own work demands castings of the highest grade, material furnished on orders will be of that quality.

AMPHIBIOUS CROCKER-WHEELER MACHINES.—The Cudahy Packing Company, Kansas City, Mo., states that it has had another flood in its plant similar to the one that occurred last year, and that both the 350-kw. and the 200-kw. Crocker-Wheeler generators have come through this unusual test successfully again. It was found necessary this time to re-tape the series field coils of the smaller generator, but no other repairs had to be made. Two submersions certainly constitute a severe test for standard machines not intended for submarines.

THE SMALLEST ENGINES AT ST. LOUIS. —Those who visit the big Allis-Chalmers engine in Machinery Hall at the World's Fair, will have an opportunity of seeing beside it the smallest operating steam engines in the Fair. These little fellows, which are made with an accuracy and finish like clockwork, stand in a glass case just across an aisle from the big engine, in the space occupied by the International Steam Pump Company. There are two of them, each working a direct-connected pump and throwing their tiny streams into a copper tank which stands between them.

THE D. & W. FUSE COMPANY, Providence, R. I., reports that its cut-outs and fuses in the Manhattan Elevated Railway equipment have been so satisfactory that the company has received the contract for furnishing the entire fuse equipment for the Subway Rapid Transit Company, which is also a part of the Interborough Rapid Transit Company's system. It is stated that this order was also secured on merit, as the engineers of the subway division have been making further tests on their own account of these large capacity fuses, and the manufacturers were called upon to submit fuses as large as 800 amperes to be tested on a dead short-circuit.

THE NERNST LAMP COMPANY has recently obtained through its Philadelphia office, in charge of A. E. Baker, the contract for lighting Rocky Glen Park, Scranton, Pa., with 100 six-glower lamps. The Philadelphia office also recently secured the adoption of Nernst lamps by the Paxtung Electric Company, Harrisburg, Pa., and that company now has over 2300 glower units in service. The Denver Office of the Nernst Lamp Company, in charge of R. D. Marthens, lately received contracts for lighting the United States Army Post at Fort Logan, Colo., and several representative establishments in Cripple Creek, Colorado. In each instance, the Nernst lamps replace incandescent lamps.

COCHRANE HEATERS FOR STEAM TURBINE PLANTS.—It is interesting to note that the General Electric Company has selected Cochrane feed-water heaters for its plants at West Lynn, Mass., and Harrison, N. J., where Curtis steam turbines are to be installed. These heaters are to be rated at 3000 and 1000 horse-power, respectively, and will take the exhaust steam from the auxiliaries. Three 5000-h.p. Cochrane heaters also have been installed in connection with steam turbines at the Delway (Mich.) station of the Detroit Edison Company, and a 600-h.p. Cochrane feed-water heater will be used in the new turbine station of the Iowa & Illinois Interurban Railway Company, Clinton, Ia. A 2000-h.p. Cochrane heater which has been ordered by the Electric Company of America will be installed with steam turbines in the new plant at Marion, Ind.

ROGERS & STARR, general contractors and engineers, recently opened offices at 827 Perry Building, Philadelphia. The senior partner, Mr. H. A. Rogers, who is a graduate of Cornell University, was in past years connected with such representative concerns as the Baldwin Locomotive Works, Boston & Albany Railroad Company, Latrobe Steel Company and Ballinger & Perrot, the latter a leading Philadelphia firm of architects and engineers. Mr. B. H. Starr was previously connected with the Camden & Suburban Railroad Company (Pottstown, Pa.), superintendent of several telephone companies and supervising engineer for the Schuylkill Traction Company. The firm will engage in civil, mechanical and electrical engineering, the installation of power plants, etc., as well as the preparation of plans and specifications for all descriptions of mechanical and electrical engineering work.

THE NATIONAL BATTERY COMPANY, Buffalo, N. Y., is one of the most active builders of storage batteries in this country. The history of this establishment is unusual. It was originally part of the American Bicycle Company, which later became the Pope Manufacturing Company, and from them the entire capital stock has been purchased by individuals, who are, at the present time, not only extending the already large factory buildings, but so improving the interior arrangements that all the manufacturing methods and systems will be thoroughly up-to-date. Electric elevators, trolley car lines, etc., will equip the factory, carrying the heavy product handled rapidly from place to place. The chemical and electrical laboratories have been greatly increased in size, and are being equipped with the very latest types in every variety of instrument required for experimental work. The spirit of the new ownership and management is bold and aggressive, having at its command all the capital and resources that will be required to make the company a success, and it is pushing on as rapidly as it is possible to go. The largest product of the factory is batteries for power plants and various kinds of stationary work. After this the railroad and telephone batteries are the important product. For the manufacture of automobile storage batteries, separate departments have been made, so that as the volume of this work rises and falls, according to the season of the year, the factory output will be fairly well able to take care of the demand, and yet not interfere with the more continuous and larger volume of business in stationary power batteries.

CENTRAL STATION NEWS

ALABAMA.

JASPER.—The Jasper Water, Light & Power Company has been incorporated with a capital of $50,000, by Messrs. J. M. Cranford, L. W. Lollar, D. K. Carter and others.

JACKSON.—Mr. George F. Brockman, of this city, is erecting a large hydraulic electric light plant here. The plant, which will be operated on the direct-current system, is expected to be in operation about October 5.

DECATUR.—The city, it is said, purposes to establish an electric light plant. Heretofore Decatur has been supplied with current for lighting purposes from the plant of the Decatur Light, Power & Fuel Company, of New Decatur.

NEW DECATUR.—The following have been chosen as officers by the Decatur Light, Power & Fuel Company; Mr. H. S. Fleming, of New York City, president; Mr. J. J. Riordan, Jr., vice-president; Mr. H. B. Lovell, secretary; Mr. John Marston, treasurer, and Mr. Charles E. Mayer, superintendent.

MOBILE.—Messrs. J. A. Maloney, chief-engineer of the Mobile Light & Railway Company; S. H. Hinckley, chief engineer at the Mobile City Water Works, and A. J. Grove, engineer of the Mobile brewery, were influential in obtaining the passage recently of an ordinance for the inspection of stationary boilers, engines and elevators and the licensing of stationary engineers, which was passed by the City Council.

BIRMINGHAM.—At a special meeting of the stockholders of the Birmingham Railway, Light & Power Company held recently, it was decided to issue $10,000,000 worth of bonds protected by a mortgage. Part of the issue will be used to retire outstanding bonds, but the greater part will be utilized to carry out projected improvements and to complete those already under way. The company has also lately secured several large steam heating contracts.

CHEROKEE.—At a recent meeting of its stockholders, the Cherokee Development & Manufacturing Company, which is arranging to construct a large water-power plant on the Tallapoosa River for the transmission of electricity to Birmingham, voted to increase its capital stock from $50,000 to $100,000. The additional $50,000 is to be devoted to the purchase of an undivided half interest in the properties of the company from Sallie A. Jones, of Montgomery. The following officers were elected: President, Mr. Thomas H. Watts; secretary, Mr. J. Thorington; treasurer, Mr. James S. Pinckard; general manager, Mr. Henry C. Jones. Mr. Jones states that work on the plant will be begun at an early date.

ARKANSAS.

NORTH LITTLE ROCK.—The petition recently submitted to the council for the construction of an electric light plant and water works resulted in the passage of an ordinance providing for the establishment of such plants to be owned and operated by the city.

MAMMOTH SPRINGS.—The Mammoth Springs Electric Light Company is perfecting arrangements to increase its service by the addition of power and day circuits, for which purpose a new three-phase alternating-current generator is to be installed. The company is also contemplating the operation of a cotton gin and corn mill.

LEWISVILLE.—The plant of the Lewisville Light & Water Company, which was recently organized, has been completed and is now in operation. The company has been awarded the contract for the city lighting. The officers are as follows: President, Mr. F. R. Daniel; secretary and treasurer, Mr. G. W. Dobson; general manager and chief electrician, Mr. John W. Miller.

CALIFORNIA.

SEBASTAPOL.—Bids have been called for for a franchise to erect poles and wires for the transmission of electricity for light and power purposes in Sebastapol.

SACRAMENTO.—Mr. John Martin is now president of the Sacramento Electric, Gas & Railway Company, and Mr. John A. Britton is vice-president and manager.

FORTUNA.—The Humboldt Milling Company has applied for a franschise to erect and maintain a pole line for the purpose of extending its electric light system to various points in the valley, including Loleta, Fortuna, Rohnerville, Alton, Hydesville, Carlotta and Table Bluff.

ALTURAS.—A 400-h.p. lighting plant is being installed on Pine Creek, about seven miles from here. Current will also be supplied to commercial plants for operating purposes. The capacity may be increased as the demands require it, the water power being sufficient to generate 2500 horse-power.

REDDING.—The new power plant of the Northern California Power Company, situated on Cow Creek thirty miles from Redding and costing $200,000, is now in operation. As has been previously stated this plant was installed to supplement the one at Shingletown, the two plants having a combined capacity of 8000 horse-power and generating 44,000 volts.

LOS ANGELES.—This city is now amply supplied with electrical power from the Kern River. The largest single installment of power ever connected to the electrical system of the city is carried by a line which brings 10,000 horse-power from a source over 100 miles away. There are 758 miles of wire which weighs half a pound to the foot, making the entire weight of wire about 1000 tons. The wires are supported on the poles by 24,000 of the largest insulators ever used in California.

SAN FRANCISCO.—The San Francisco Gas & Electric Company has been directed by the Board of Supervisors to install forty new arc lamps in the southern part of the city. The work of renewing the city's street arc lighting system, at a cost of $50,000, will be carried on as rapidly as the Westinghouse Electric & Manufacturing Company can supply the new lamps, of which some 1500 have been ordered. These will be of the enclosed-arc type and each one will be hung on a bracket about four feet from the pole, so that there will be a minimum of shadow.

MONTEREY.—Articles of incorporation have been filed by the Vantana Power Company, fixing the capital stock at $500,000. Messrs. C. P. Bradford, of San Francisco; W. E. Bradford, of San Jose; F. L. Ordway and C. V. Hove, of Monterey; F. C. Richardson and C. M. Howard, of Pacific Grove, and H. S. Bradford, of Evergreen, are the directors. The company purposes building a large dam at the junction of Vanta Creek and the Big Sur River, 40 miles south of Monterey, where it is said that from 3000 to 5000 horse-power can be developed. The current generated by means of the water power will be transmitted to Monterey over a high-tension transmission line.

YREKA.—The Siskiyou Electric Power Company, which recently acquired the plant and business of the Aetna Electric Light Company, also controls the Ashland Electric Power & Light Company of Ashland, Ore. New machinery is to be installed soon in the power house of the company, consisting of a 750-kw. generator and a new water wheel. The current generated at the main plant is distributed through seven sub-stations located in Montagne, Yreka, Grand View and Etna, and at the Mt. Vernon and New York mines. Electricity for lighting purposes is supplied by the company to Etna, Fort Jones, Montagne and Greenview. The officers are as follows: President, J. Churchill; vice-president, J. W. Churchill; secretary, A. J. Roseborough; treasurer, J. P. Churchill; manager, E. H. Steele; superintendent and chief engineer, C. G. Steele; chief electrician, F. G. Robley.

RICHMOND.—The Richmond Light & Power Company, whose office is in the Crocker Building, San Francisco, has discontinued the use of its steam plant, having recently entered into a contract with the Bay Counties Power Company for the purchase of electric current for a term of ten years. The steam plant is maintained in good condition, however, and may be started up at any time should it be required. In order to connect the company's system to the lines of the Bay Counties Power Company it was necessary to install three 100-kw. and three 50-kw. 50,000/2200-volt transformers of General Electric make. The plant is now supplying a 24-hour service and is furnishing approximately 500 horse-power to 60-cycle, three-phase induction motors. The lighting load consists of 3500 16-c.p. lamps and 65 alternating-current arc lamps. The arc lamps supplied to the town of Richmond are paid for by public subscription, as the town has not yet been incorporated, the rate for same being $75 per year on the basis of a one o'clock every night schedule. The rate for commercial arcs is $6 per month per lamp burning until midnight and $9 per month for all-night service. All current is sold on the meter basis. The following are the present officers of the company. President, W. G. Henshaw; vice-president, W. A. Bissell; secretary and treasurer, C. W. Waller; manager, H. B. Kinney.

COLORADO.

GOLDEN.—The Golden Illuminating Company has recently installed at its plant a new 150-kw. generator direct-connected to a water wheel.

VICTOR.—The Pike's Peak Power Company has completed the construction of its hydraulic electric plant and has consolidated with the Pueblo Traction & Lighting Company. Mr. R. M. Jones, chief engineer and general superintendent of the former company, has severed his connection with that company and is now free to undertake other consulting engineering propositions.

CONNECTICUT.

NEW LONDON.—The Groton Water & Electric Company will increase its facilities at the power house and pumping station at Poquonoc by the installation of a 250-h.p. steam engine.

DELAWARE.

WILMINGTON.—The Susquehanna Light Company has been organized with a capital of $75,000.

NEW CASTLE.—New Castle is now supplied with light, current for which is generated at the plant of the Wilmington, New Castle & Southern Railway Company. The following are the officers of the company: H. L. Evans, president; Willard Saulsbury, vice-president; C. P. Holcomb, secretary and superintendent; F. R. Morrison, treasurer; M. K. Lancaster, chief engineer, and George Unger, chief electrician. Current is supplied to 35 2000-c.p. city arc lights and 800 16-c.p. commercial incandescent lights.

DISTRICT OF COLUMBIA.

WASHINGTON, D. C.—At the annual meeting of the stockholders of the International Motor & Power Company, held recently, the following trustees were elected: Hopewell H. Darnielle, Washington; Samuel W. Smith, M. C., Pontiac, Mich.; Charles F. Joy, St. Louis, Mo.; Senator Jacob H. Gallinger, of New Hampshire; Alexander H. Bell, Washington; William L. Walter, Port Huron, Mich.; Lieut. Commander Frank W. Bartlett, U. S. N.; Edgar Weeks, Mt. Clemens, Mich.; Bert H. Brockway, Washington; Maj. Henry L. Biscoe, Washington; Tomkins C. Delavan, New York City; Charles H. Fred, J. S. Ziegler, S. H. Bell and Francis Nye, of Washington.

In the District of Columbia the electrical regulations regarding the production, use and control of electricity have been passed upon by the corporation counsel and pronounced correct, with the suggestion that the regulations be advertised a month before going into effect.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

FLORIDA.

PENSACOLA.—The Pensacola Suburban Electric Company has been organized here by A. C. Berry, J. E. Wolf and others.

OCALA.—The citizens have voted for a bond issue of $45,000, a portion of which will be used in improving the electric light plant.

ST. AUGUSTINE.—Reports state that Mr. T. R. Osmond, of New York City, contemplates establishing an electric light plant at this point.

MIAMI.—The Miami Electric Light Department of the Florida East Coast Hotel Company successfully started its new city lighting plant a short time ago. Hitherto the city has been lighted from the company's plant in the Hotel Royal Palm. The new plant is operated on a 60-cycle two-phase 2300-volt system, the equipment consisting of two G. E. 100-kw. engine-type generators with Ball & Wood tandem compound condensing engines and Oil City boilers arranged to burn wood with mechanical draft.

TAMPA.—The Tampa Electric Company is now preparing to erect and install one of the largest electric power houses in the South. The plant will be located on the Hillsboro River, on the site now occupied by the temporary plant. The frame building housing the temporary plant will be removed and the brick structure erected in its place, covering considerably more ground than the present one. The plans for the new plant and building have already been prepared. The building will be 50x100 feet, and the new boilers and machinery will give a capacity of 1000 horse-power. Ground has been broken, and the company expects to have the new plant in use by November 1. During erection and installation, the temporary plant now on the ground will continue in use.

GEORGIA.

WRIGHTSVILLE.—The Wrightsville Electric Light Company has been organized here with Mr. A. T. Cobb as president.

DOUGLAS.—Bonds to the amount of $20,000 have been sold to provide for the construction of an electric light plant and water works.

BAINBRIDGE.—The citizens have voted in favor of purchasing the present electric light plant, for which purpose $20,000 bonds will be issued.

COLUMBUS.—Mr. H. A. Tibbs announces that he has severed his connection with the Columbus Power Company to take charge of the York Haven Water & Power Company's plant at York Haven, Pa.

GRIFFIN.—The citizens have voted for a bond issue of $100,000, of which $35,000 will be expended in improving and extending the electric light system and water works, for which plans and specifications are being prepared.

GRIFFIN.—The stockholders of the Flint River Power Company have organized with W. J. Kincaid, president, and J. P. Nichols, secretary. The company has a cash capital of $25,000, with the privilege of increasing it to $500,000, and will in the near future construct an electric power plant at Flat Shoals.

MOULTRIE.—Mr. Guy P. Felton, who has been superintendent of the Moultrie Electric Light & Water Works for the past three years, has resigned that position to accept a similar place at Blakely. He has been succeeded here by Mr. M. A. Barr, of Columbus, who assumed the duties of his new position August 15.

THOMSON.—Bids have been received for furnishing material and constructing an electric light plant, consisting of a brick power house; a 66-in. x 16-ft. high-pressure boiler, heater and feed pump; one 135-h.p. engine, one 90-kw. alternator and station apparatus, six arc lamps, 36 50-c.p. series incandescent lamps, 800 lights capacity in transformers, wire, poles, lines, etc.

GAINESVILLE.—A short time ago fire destroyed the warehouse of the North Georgia Electric Company, entailing a loss of $20,000 with no insurance. In the building were stored part of the machinery for the Chattahoochee power house and parts of the merry-go-round being erected at the park, together with a number of barrels of cement. The loss will delay the utilization of the new power house, as considerable time will be required to secure new machinery.

IDAHO.

AMERICAN FALLS.—The three general electric companies operating here have been consolidated under the name of the Idaho Consolidated Power Company.

MONTPELIER.—The Montpelier Electric Light Company has in course of construction a new 750-h.p. water-power plant. Mr. J. R. Brennan is president; D. Orr Paynter, vice-president; J. A. Rostan, secretary and manager, and J. F. Perkins, chief electrician.

BOISE.—The Electric Power Company, Ltd., is now supplying current for 40 2000-c.p. arc commercial lights and 4000 16-c.p. incandescent lights, and is also operating a day circuit, supplying current for power purposes at 110 volts. Mr. Harry D. Pope is manager and superintendent of the plant.

PECK.—Mr. Lakin, the owner of the mill here, has submitted two propositions to the business men of the town. The first is that if the town is incorporated he will put in an electric light plant and contract with the town for furnishing lights; or if the town prefers to own its plant he will furnish the power for operating the same at cheap rates.

ILLINOIS.

ONEIDA.—The Onedia Light & Power Company is installing meters and in the future all current will be charged at meter rates.

DE KALB.—It is said that a new power plant is being installed here by Mr. J. Haisch, which will furnish lights for the town.

GENESEO.—The Geneseo Electric Light Company has just closed a five-year contract with the city authorities to supply the lighting current for the town.

SAYBROOK.—The Saybrook Electric Light, Heat & Power Company has filed articles of incorporation, fixing its capital stock at $10,000. Mr. E. E. Sayler is among the directors.

ROCKFORD.—At a meeting of the stockholders of the Central Heat & Power Company, it was decided to expend about $30,000 for additional machinery, the improvements to be made at once.

HOMER.—The plant of the Homer Light & Power Company has recently changed hands, it having been purchased by W. S. Thomson, of Fithian, and G. C. Browen for a consideration of $8000.

ALPHA.—Improvements are under way at the plant of the Alpha Electric Light & Power Company, whereby it will be enabled to extend its service to Rio, Knox County, this fall, and possibly to Mola and North Henderson in Mercer County.

PEORIA.—The council has advertised for bids for furnishing 675 electric street lights of not less than 2000 candle-power for two years from November 1 on an all-night schedule for every night, also for 32-c.p. incandescent lights for alley lighting.

CHICAGO.—The Illinois Heating & Light Company has been granted a charter to establish a heat, light and power plant. Messrs. E. T. Noble, C. E. Moore and J. S. Huey are among the organizers of the company, which has a capital stock of $15,000.

KEITHSBURG.—The plant and business of the Keithsburg Electric Light & Power Companw have been acquired by A. L. and O. B. Hayden. The new owners, it is said, contemplate making changes in the plant and equipment which will greatly improve it.

EDINBURG.—Articles of incorporation have been filed by Messrs. J. R. Harrington, L. E. Swigert and Reuben Wilkinson for the Edinburg Light, Heat & Power Company. The company's capital stock is $30,000 and its purpose is to operate a light, heat, power and water plant in this city.

CHICAGO.—Fifteen hundred new arc lamps will be installed on 30 miles of streets of the Northwest Side, Chicago, when the new electric lighting station planned by city electrician Ellicott at Fullerton Avenue and the North Branch of the Chicago River is completed. This will be one of the first results of the bond issue for permanent improvements. The station will cost $100,000 and Mr. Elliott expects to have it completed by January 1.

GRANITE CITY.—The city authorities are desirous of having some responsible company locate here for the purpose of putting up and operating a modern electric light and power plant. A plant would be required capable of supplying 150 arc lights and 5000 incandescent lights, having also a sufficient capacity to furnish current to the various industries of the city demanding power. Mr. Fred A. Eisele, of the City Light Committee, states that the town is one of the best in the State and he considers the opportunity an excellent one for the right parties.

INDIANA.

ELKHART.—The Conn Electric Company is making arrangements to extend its electric light service to Goshen.

MARION.—A 2000-h.p. Cochrane heater has been ordered by the Electric Company of America to be installed with steam turbines at its new plant in this city.

ALEXANDRIA.—A contract has been awarded by the City Council to the Alexandria Electric Light & Power Company for lighting the city streets for a period of ten years.

SHELBYVILLE.—Mr. N. B. Stabley has petitioned the Board of County Commissioners for a franchise permitting him to erect poles and string wires for supplying current for lighting purposes.

SOUTH BEND.—The Economy Electric Corporation has been organized with a capital stock of $10,000. The directors are named as follows: Ulysses S. Meeks, Cora M. Meeks, William F. Wood and Blanche D. Wood.

VINCENNES.—Various improvements are under way at the power plant of the City Electric Lighting Company, which include the installation of new boilers, engine and dynamos and the extension of the incandescent feeders and arc circuits.

RICHMOND.—Mr. S. A. Gard, superintendent of the municipal electric light plant since it was put in operation two years ago, has resigned his position and left the city. Mr. Charles Rodgers has been appointed as his successor. After the city's contract with the Light, Heat & Power Company expires in September, the streets will be lighted by current from the municipal plant, the council having rejected the company's proposition to light the city at $60 per lamp per year.

FORT WAYNE.—The syndicate of capitalists which recently purchased the Jenney Electric Light & Power Company, merging it with the Fort Wayne Electric Light & Power Company, at a meeting held recently, elected E. C. Werner, of New York, president, to succeed H. P. Bondhight; J. W. White, vice-president; treasurer, F. S. Hunting; secretary and manager, C. G. Guild. The company expects eventually to secure control of the entire electric light and power business of Fort Wayne, that city's traction lines and all of the interurban lines centering there, in addition to a large interest in the Indianapolis Traction & Terminal Company, the Union Traction Company, of Indiana, and the Fort Wayne & Wabash Valley Company. The new company, it is said, will erect an enormous power house capable of lighting the city and of furnishing power for the city and park and the interurban lines. The company controls a franchise for steam and hot-water heating and the exhaust from the power house will be utilized in this way.

INDIAN TERRITORY.

WILBURTON.—The contract for constructing the proposed $50,000 electric light plant for this place has been awarded to James Dignan.

PAULS VALLEY.—The electric light plant of Thompson Brothers, which was destroyed by fire a few weeks ago, will be replaced by a new plant which will be built at once.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

IOWA.

LAMONI.—It is understood that Mr. M. L. Burt, of Bedford, Ia., is negotiating for the purchase of the electric light plant here.

GREENE.—Reports state that a company has been organized to purchase and operate the electric light plant, now owned by Mr. F. J. Pfiffner.

LAKE CITY.—The Lake City Electric Company's plant, which is controlled by local capital, has been leased for a term of years to Otto E. Brownell.

WILTON JUNCTION.—Plans have been prepared by Mr. G. W. Bissell, of Ames, Ia., for the improvements to be made to the village electric light plant, for which $5250 bonds were recently issued.

BOONE.—The proposition for municipal ownership of the electric lighting plant, which has been so vigorously agitated of late, was defeated at the recent election. The council has awarded the contract for the city lighting for a period of five years to the Boone Electric Light & Street Railway Company at the rate of $62.50 per light per year for 80 lights of 1200-c.p. each.

WAUKON.—The Waukon Electric Light Company, in connection with the Decorah Electric Light Company, of Decorah, Winneshiek County, is preparing plans for a water power plant to be constructed on the upper Iowa River about 12 miles from Decorah to supply power to the two towns and adjacent territory. Construction work will begin as soon as the proposition can be financed.

KANSAS.

EMPORIA.—Mr. W. O. Johnson, of Winfield, proposes to establish a $20,000 electric plant in this city.

MANHATTAN.—C. P. Dewey, of Chicago, president of the Manhattan Ice, Light & Power Company, of this city, died recently.

OSKALOOSA.—The power and lighting plant of the Oskaloosa Electric Light Company is in charge of Mr. J. S. Buck as manager.

CONCORDIA.—The Home Light & Power Company has been chartered to build and operate electric light and power plants, with a capital of $50,000.

NESS CITY.—The Ness City Electric Light Company has been organized by Messrs. C. H. Brassfield and A. S. Foulks. The company has secured the city lighting contract and is operating its light plant by means of power supplied by the Ness City Milling Company. It is the company's purpose, however, to install its own power plant in the near future, to be run in connection with an ice plant. Mr. Foulks is secretary and treasurer, Mr. Brassfield is manager and superintendent, and Mr. B. Hawkins is chief engineer and electrician.

KENTUCKY.

FULTON.—The Fulton Electric Light & Power Company is adding a 150-h.p. boiler to its plant equipment.

DANVILLE.—The council has advertised for bids for the purchase of a twenty-year franchise to construct, maintain and operate an electric lighting and power plant in the city. The purchaser of said franchise shall also have the right to construct, operate and maintain an electric railway throughout the city.

HOPKINSVILLE.—The Hopkinsville Gas Light & Power Company has been reorganized under the name of the Hopkinsville Gas & Electric Company and articles of incorporation filed by Messrs. W. T. Tandy and James A. Young, Jr., of this city, and W. H. White, of Cadiz. The capital stock is $25,000. It is presumed that the plant will be rebuilt with as little delay as possible.

LOUISIANA.

LAFAYETTE.—The City Council has awarded a contract to the Standard Electric Company, of New Orleans, for two dynamos of 1500 lights capacity each and one 250-h.p. engine to be installed in the city plant.

ABBEVILLE.—The Abbeville Light, Power & Water Works Company has in preparation plans for installing a 15-ton ice plant. Heavier mains will be put in than those now in use, and a generator set is to be added to the equipment of the power plant.

NEW ORLEANS.—The Consumers' Electric Light & Power Company will, it is announced, shortly commence the work of erecting its plant. The company is backed by retail merchants of this city, all of whom are subscribers to the stock and will utilize the power developed.

PROVIDENCE.—The town proposes to issue bonds for a water and electric light plant.

MAINE.

PORTLAND.—The stockholders of the Rumford Falls Power Company, of this city, have voted to increase the amount of its capital stock from $500,000 to $800,000.

BRUNSWICK.—Low water in the Androscoggin River recently necessitated a shutdown for a few hours at the plant of the Brunswick Electric Light & Power Company. Other plants depending upon the water power were obliged to suspend operations temporarily.

SOUTH WINDHAM.—Considerable damage was done by lightning recently to the plant of the Mallison Falls Power Company at Mallison Falls, near this city. The dynamos, switchboards, lightning arresters and other pieces of apparatus were considerably damaged and it was several days before the plant could be put in shape for work. The plant furnishes power to several industrial concerns and also supplies current to the Portland Railroad Company for the operation of its cars from Westbrook to South Windham.

MARYLAND.

FREDERICK.—Extensive improvements are about to be made to the electric light plant of the Frederick Gas & Electric Company. The company has purchased two new dynamos, two engines, one of which is a 200-h.p. Corliss engine, a large amount of copper wire and other materials for reconstructing its lighting system.

MT. WASHINGTON.—The county commissioners have closed a contract with the Mount Washington Electric Light & Power Company for furnishing electric lights for public highways at Mount Washington, Arlington, Govanstown, Towson, Lutherville, Pikesville, Glyndon and Riderstown. The contract is for five years, and the company is allowed $35 per year for lights of 60 candle-power and $25 per year for 32 candle-power lights, to be kept burning on nights when the moon is not shining. The company is allowed $42 per year for lights of 60 candle-power and $36 per year for lights of 32 candle-power, to be burned all night.

MASSACHUSETTS.

HUDSON.—The municipal light and power plant will furnish electricity for motive power after September 1.

HAVERHILL.—A 300-h.p. engine has been installed in the Charlesworth power plant which furnishes current for nearly all the factories on Washington Street.

PITTSFIELD.—E. P. Stearns, of Boston, is preparing plans for a power plant to be situated on the Housatonic River at Pittsfield. A stock company is being formed with a capital of $500,000.

NEWTON.—The Newton & Watertown Gas Light Company, which is controlled by the Edison Electric Illuminating Company of Boston, will discontinue the operation of its generating plant and will obtain electricity from the Edison Company.

BOSTON.—Mr. Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston, was recently presented a fine bronze bust of Edison by his employes, associates and friends. The bust stands on a pedestal, the total height being 6 ft. 3 ins.

BEVERLY.—The Beverly Gas & Electric Company has been making additions to its already well-equipped station. Three new 150-kw. alternating-current generators and a new marble switchboard are among the improvements, and the company is now furnishing a twenty-four-hour service, lighting Manchester-by-the-Sea in addition to Beverly.

LEOMINSTER.—Mr. Benjamin F. Peach, of Lynn, Mass., at a recent meeting of the stockholders was chosen clerk of the Leominster Electric Light & Power Company to succeed the late Dr. C. A. Wheeler. Mr. Peach is also a director of the corporation.

TURNERS FALLS.—The Franklin Electric Light Company elected the following officers at its annual meeting: President, J. F. Bartlett; secretary, E. I. Cassidy; treasurer, W. C. D. Thomas. The board of directors is composed of Messrs. Porter Farwell, C. W. Hazleton, H. D. Bardwell, W. D. Russell. Within the next year the company expects to be able to obtain power from the Turners Falls Company and will then be in position to greatly extend its system in the village.

MICHIGAN.

PLAINWELL.—The Brownell Electric Company has been granted the village lighting contract.

COLDWATER.—Mr. A. L. Pond has been reelected superintendent of the water works and electric light plant at this place.

PLAINWELL.—A new company has been formed here, known as the Easley Light & Power Company, with a capital stock of $30,000.

BAY CITY.—Bonds to the amount of $49,500 have been issued by the Electric Light Department for electric light improvements to enable the city to establish a commercial plant.

IONIA CITY.—The lighting contract between the city and the Ionia Electric Company expires in October, and bids are being advertised for preparatory to making a new contract.

ESCANABA.—It is understood that the city of Escanaba is likely to discontinue its municipal lighting business, as its operation of the electric light plant has not been a financial success, it is said.

DETROIT.—The new 800-h.p. engine recently installed in the power house of the City Electric Light Plant has been put in operation. The engine-generator unit developed under test a capacity of 570 kilowatts.

ST. IGNACE.—The city authorities have issued $15,000 bonds for the installation of an electric light plant to take the place of the one recently destroyed by fire, and is now in the market for a complete incandescent plant.

ALPENA.—The sale of the $250,000 water and electric light bonds made on June 25 has been declared off. The bonds have been readvertised and as soon as the bids have been received and opened the contracts will be awarded.

PONTIAC.—The old arrangement of lighting the streets only on dark nights has been discontinued, and a ten-year contract for lighting the city every night has been awarded to Mr. J. C. Hoffman, of Detroit, at the rate of $57.30 per light per year.

DETROIT.—Mr. Frank Hellen, of the Detroit City Gas Company, recently resigned his position as superintendent of distribution to accept a responsible position in Rochester, N. Y., with the gas, railway and electric lighting company of that city. On leaving the Detroit Company he was presented with a diamond by about fifty of his associates.

LANSING.—Improvements to cost $20,000 are to be made to the city lighting system and plant, and the following contracts have been awarded for machinery: To the Buckeye Engine Company for a 600-h.p. engine, the Bullock Electric Manufacturing Company for a 425-kw. generator, and the George F. Blake Manufacturing Company for a condenser.

MANISTIQUE.—The Manistique Light & Power Company has in preparation plans for extensive improvements. These include a new building for its plant, which is to be materially enlarged in order to meet the demand for power of new industries now locating in this city. It is estimated that about $50,000 will be spent for the purpose. The energy utilized is obtained from the river, which is harnessed near the point at which it empties into Lake Michigan.

LYONS.—Mr. H. R. Wager is at work rebuilding the plant which was ruined by the flood last winter at Wagar's dam, the channel of the river being changed so that there is no water within

25 feet of the dam. The power house will be located on the south bank of the present river, about 200 feet south of the old one. The dam will be extended 150 feet, giving it a total length of 350 feet, and every precaution will be taken to make it flood-proof. The capacity of the plant will be materially increased, the cost of rebuilding it being estimated at $50,000.

NEGAUNEE.—The new electrical apparatus for the municipal lighting station has been installed and the efficiency of the plant has been increased. The two small generators have been displaced by a 200-kw. generator capable of supplying both the lighting and power circuits with current. Other machinery installed includes a 250-h.p. engine, a condenser, heater and duplex pump, besides several smaller pieces. Superintendent T. E. Gaffney has also made various improvements in the lighting circuits, including the installation of new enclosed arc lamps. Another improvement is embodied in the division of the city into two sections, which arrangement, together with separate transformers, gives independent service for each section of the city. A new switchboard has been put in, and No. 2 wire has been substituted for Nos. 6 and 8 in the secondary leads.

MINNESOTA.

VIRGINIA.—It is stated that the Virginia Light & Water Company has arranged to sell its plant to the city.

ROYALTON.—The citizens of Royalton have voted an issue of $10,000 bonds for the erection of a lighting plant.

CASS LAKE.—The new plant of the Cass Water, Light & Power Company has been completed and is in operation.

HIBBING.—Mr. O. P. Finnes has succeeded Mr. J. B. Leary as superintendent of the municipal light and water plant.

SPRING VALLEY.—Plans and specifications for a municipal lighting plant to cost about $10,000 have been adopted by the city authorities.

JORDAN.—The Jordan Electric Light & Heating Company contemplates installing a storage battery and a day circuit for power purposes.

LAKEFIELD.—Mr. Frank Burbank has resigned as superintendent of the Lakefield electric light plant, to accept a similar position at St. James, this state.

WINONA.—The Winona Railway & Light Company will issue bonds to the amount of $400,000 with which to refund its old indebtedness and improve and extend its present system.

MANKATO.—The Mankato Railway, Light & Power Company, recently organized, has been granted a franchise for the operation and maintenance of a light and power plant and an electric railway system.

MISSISSIPPI.

BILOXI.—The Biloxi Electric Railway & Power Company is making the neecssary changes in its plant to enable it to operate a day circuit.

NEW ALBANY.—The citizens have voted to issue $20,000 bonds for the establishment of an electric light plant and water works system.

MAGNOLIA.—The Magnolia Electric Light Company is planning to install a new 150-kw. alternator and engine in its plant. The officers of the company are as follows: President, J. H. Pine; vice-president, Samuel Abram; secretary and treasurer, E. D. Reid; manager and superintendent, Xavier A. Kramer; chief engineer, J. Wall; chief electrician, S. P. Curlette.

MISSOURI.

AURORA.—The Aurora Light, Ice & Storage Company is arranging to introduce series alternating street arc lighting.

JOPLIN.—The proposition to bond the town for $30,000 to increase the capacity of the municipal electric plant has been carried.

LA PLATA.—The La Plata Electric Light Company is arranging to install a new engine and generator which will enable it to increase its service from midnight to all night. The company also lights Moulton, La.

COLUMBIA.—The city has purchased the property of the Columbia Water & Light Company for $67,000. The property consists of water works and an electric light plant. It will be controlled by a Board of Public Works composed of four members, appointed by Mayor Niedermeyer, as

LEXINGTON.—The Lexington Gas & Electric Company has in contemplation improvements which mean practically the reconstruction of its entire system. The town is to be rewired throughout and new enclosed arc lights installed. At the power house the old equipment is to be replaced by new engines and dynamos, new transformers and new meters.

MONTANA.

GREAT FALLS.—The Swift Current Oil, Land & Power Company, of this city, expects soon to commence operations in Teton County. The company is capitalized at $2,000,000 and a large amount will be spent in extensions and improvements in the immediate future.

NEBRASKA.

OMAHA.—The Bennett Company has been organized here with a capital of $80,000 for the purpose of acquiring light, heat and power plants.

SHELBY.—Mr. G. P. Safstrom, proprietor of the electric light plant here, is preparing plans to extend his circuits and is considering a change in voltage, current now being generated at 130 volts.

VALENTINE.—The electric light plant of this place is run in conjunction with the Minnechadusa Mill and is owned by Mr. S. F. Gilman. Mr. C. S. Gould is manager of the plant and Mr. J. L. Hewitt, chief electrician. Current is supplied to 9 city arc lights, 18 commercial arc lights and 800 commercial incandescent lights, on an all-night schedule.

NEVADA.

RENO.—The Electric Light Company is reported incorporated, with a capital of $50,000, by G. H. Taylor, C. E. Horton and others. The principal place of business will be in Reno.

NEW HAMPSHIRE.

MILFORD.—In rebuilding the dam of the Milford Electric Light Company, which was damaged by the spring floods, the "crib" style was used, it being claimed that it would better withstand the ravages of the ice. The timber is green white pine, the open space in the dam being filled with stones and boarded over at the top.

NEW JERSEY.

WASHINGTON.—The Washington Electric Light Company is considering adding a day circuit to its service,.

NEWARK.—The Inter Gas & Power Company has been incorporated with a capital stock of $1,000,000. F. W. Hatch and G. D. Russell are among the directors.

JERSEY CITY.—The Burke Electric Company has filed articles of incorporation, showing a capital stock of $50,000. James Burke, Francis E. Drake and Paul Wilcox are the incorporators.

CAMDEN.—The Monterey Electric Street Railway, Light & Power Company has filed articles of incorporation stating its capital stock to be $225,000. T. H. Beckett and E. F. Walker, with others, form the board of directors.

METUCHEN.—The Metuchen plant of the Public Service Corporation is being enlarged and two 500-kw. G. E. generators direct-connected to Curtis turbines have been contracted for. The installation is expected to be in running operation by the first of October. The lighting and power plant of the company at Plainfield will then be discontinued and converted into a sub-station.

NUTLEY.—A contract has been made by the Council with the Public Service Corporation, whereby the company is to provide 238 25-c.p. incandescent street lights at $16 per lamp. The contract is for one year, with the privilege of renewal for five years. The town has heretofore paid $14 per 32-c.p. light, with free lamps in council rooms, schools, fire houses and in front of each church. In addition to raising the price per lamp and reducing the candle-power, all free lights have been abolished by the Public Service Corporation.

NEW MEXICO.

CARLSBAD.—The Public Utilities Company has been organized here with a capital stock of $100,000 for the purpose of acquiring, installing, owning and operating telephones, telegraph lines, etc., and to acquire, construct and maintain a dam for the production of water-power which shall be used to generate electrical energy for electric light systems. The incorporators of the company are William A. Finley, Matthew S. Grooves, William J. Barber, J. O. Cameron and Dr. Fred F. Doepp.

NEW YORK.

DUNKIRK.—Mr. James Larson is now chief engineer of the Dunkirk Power & Heating Company.

WATKINS.—Bonds to the amount of $20,000 have been sold for the construction of the municipal electric plant.

CANAJOHARIE.—The plant of the Montgomery County Electric Light & Power Company has been destroyed by fire.

CORNING.—A new 250-kw. alternating-current generator is being installed in the plant of the Corning Gas & Electric Company.

FULTON.—The Fulton Light, Heat & Power Company is making arrangements for improvements to its water power system.

WARWICK.—Mr. Emil Geppet has succeeded Mr. J. Vanderhoff as chief engineer of the Warwick Valley Light & Power Company.

DUNDEE.—Mr. Edward L. Bailey, proprietor of the electric light plant of this place, is perfecting plans for pumping his water supply.

DESPATCH.—Messrs. A. H. Bown, W. W. Bown and W. P. Thistlewaite are named as directors of the Despatch Heat, Light & Power Company in the articles of incorporation recently filed by that company. The capital stock is fixed at $500,000.

PLATTSBURG.—Articles of incorporation have been filed for the Lozier Light & Power Company by E. R. Lozier, H. A. Lozier, Jr., and Samuel Regan.

FULTON.—It is stated that the Fulton Light, Heat & Power Company has accepted a contract offered by the board of public works to furnish the city with lights at $75 each.

BROOKLYN.—Commissioner Oakley, of the Department of Water Supply, Gas and Electricity, has been directed to have the overhead feed wires in numerous streets in the borough placed underground.

LOCKPORT.—The American District Steam Company has petitioned the Council for a franchise to install a system for supplying electricity for light, heat, power and refrigerating purposes in this city.

NEW YORK CITY.—The Knickerbocker Light & Heat Company of New York has filed articles of incorporation, placing the capital at $550,000 and naming the following directors: F. P. Billmeyer, H. R. Brayton and H. S. Fairchild.

KEYPORT.—The Middlesex & Monmouth Electric Light, Heat & Power Company and Jersey Central Traction Company have elected the following officers: President, Julius Christensen; treasurer, J. H. Morris; manager, F. D. Low; superintendent, Samuel Haigh.

MECHANICSVILLE.—The stockholders of the Halfmoon Light, Heat & Power Company recently elected the following directors: John C. Duncan, H. O. Bailey, William L. Howland, E. H. Strong, S. Nelson Lee, Stephen Lee, A. J. Harvey, Fred H. Ferris, Thomas Slavin, Dr. George Hudson and W. R. Palmer.

BUFFALO.—The Russell Power & Manufacturing Company, which has the same directors as the Central Power & Manufacturing Company, organized to furnish electricity in Albany and other eastern New York counties, has been incorporated with a capital of $20,000 and will extend its operations to several western counties of the State.

MOHAWK.—The high-tension wires of the Herkimer County Light & Power Company, which are to furnish light for this village, are to run along the tow-path from Little Falls to the village. The work has been commenced and ex-Canal Superintendent Wallace has been appointed state inspector of the work.

CATTARAUGUS.—The following are the present officers of the Cattaraugus Electric Light & Power Company: S. F. Binger, president; O. J. Setter, vice-president; H. B. Easton, secretary,

treasurer and purchasing agent; F. Crawford, manager and superintendent; George W. Barton, chief engineer and electrician.

ROSLYN.—The Nassau Light & Power Company, which is a consolidation of the Roslyn Light & Power Company, Franklin Electric Ice Company, North Hempstead Light & Power Company and the municipal plant of the village of Hempstead, has in course of construction a new sub-station on the tide water at Glenwood, Long Island.

COHOES.—The annual meeting of the stockholders of the Mechanicsville Electric Light Company was held recently, when the following directors were elected: James Greenaway, M. F. Farron and Edwin Farron. The directors elected these officers: President and treasurer, Edwin Farron; vice-president, James Greenaway; secretary, M. F. Farron.

GENEVA.—Plans are under way for the consolidation of the electric light plants of Auburn, Waterloo, Seneca Falls and this city. The electric power and lighting plants in this city, Waterloo and Seneca Falls are already under the management of one company, the Geneva Power & Light Company, and it is said the plans also contemplate the acquiring of the Auburn plant.

NIAGARA FALLS.—The control of the Niagara Falls Gas & Electric Light Company is said to have passed into the hands of Canadian capitalists. The company has been reorganized and the following officers elected: President, F. A. Dudley, Niagara Falls; vice-president and treasurer, Frederic Nicholls, Toronto; temporary secretary, Harry Highland, Niagara Falls.

TAUGHANNOCK.—The new power plant being built by the Ulysses Electric Light & Power Company at Taughannock Falls, under the direction of Mr. Gardner S. Williams, is rapidly approaching completion and the work is being pushed with the utmost vigor. With this new source of power it is expected to furnish electric service to the towns of Trumansburg, Jacksonville, Taughannock, Interlaken and all intervening points.

NIAGARA FALLS.—The Niagara Falls Power Company is building a new 24-duct conduit from the New York end of the upper steel arch bridge in Niagara Falls up Niagara Street to Fourteenth Street and thence to its power stations. In this conduit will be placed the cables that will connect the plant of the Canadian Niagara Power Company with the generating stations of the Niagara Falls Power Company, thus ensuring a continuous-current service to the patrons of both companies.

LOCKPORT.—The directors of the Niagara, Lockport & Ontario Power Company are stated to have voted to authorize the issue of a mortgage of $24,000,000 upon the company's corporate property to secure a like issue of bonds. This is preliminary to the construction of the Lockport power canal. Rights of way and options on property have been secured, and the company proposes to establish its plant, for the purpose of supplying electric power over as wide a radius as possible. The company will now transmit electricity as far east as Utica and as far south as Pennsylvania.

ALBANY.—The Gentral Power & Manufacturing Company, of this city, has filed a certificate of incorporation. The company proposes to manufacture electricity for light, heat and power purposes. The capital stock is $10,000, and the directors are Charles R. Huntley, William R. Huntley and D. T. Nash, all of Buffalo. The company will operate in the counties of Schenectady, Saratoga, Albany and Rensselaer, the cities of Schenectady, Cohoes, Watervliet, Troy and Albany and the towns of Glenville, Rotterdam and Niskyuna, Schenectady county; Clifton Park, Half Moon, and Waterford, Saratoga County; North Greenbush, Rensselaer County.

LOCKPORT.—The Niagara County Irrigation & Water Supply Company is stated to have filed in the County Clerk's office at Lockport a map of a canal, the route of which is from La Salle, where it takes in the water of Niagara River, directly and also through Cayuga Creek, in a northwesterly direction, nearly parallel with the Military Road to Pletcher's Corners at the northeast corner of the city of Niagara Falls, along Bloody Run, to the bank of Niagara River, just above Devil's Hole, where there is a sheer drop of 300 ft. It is proposed to erect a power house and plant at the Devil's Hole, capable of generating 150,000 horse-power. The canal will be 120 feet wide and carry 18 feet of water from the intake to Pletcher's Corners, and from there to the Devil's Hole it will be 60 feet wide and 18 feet deep. The contract for the construction work of the canal has been awarded to the Frontier Construction Company of New York. The enterprise is said to involve an expenditure of $10,000,000.

NORTH CAROLINA.

RALEIGH.—The Raleigh Electric Company is considering some much needed extensions in the city.

KINSTON.—Mr. J. A. Harvey is superintendent of the municipal electric lighting plant of this city.

LUMBERTON.—The town now operates its own electric light plant, which is in charge of Mr. E. G. Couch, superintendent.

ROPER.—The electric plant operated by the Blount Milling Company has been sold to Mr. George W. Roper, of Norfolk, Va.

SOUTHERN PINES.—The R. L. Chandler Electric Light Plant, which furnishes light to the towns of Troy and Biscoe and whose office is in this city, is considering installing a small auxiliary steam plant shortly. Orders have been placed for the boiler and engine.

RAEFORD.—A charter has been granted to the Raeford Power & Manufacturing Company, with a capital of $200,000. The stockholders are J. W. McLaughlin, T. B. Upchurch and John Blue. The company will develop water and electric power and operate textile plants.

ASHEVILLE.—The W. T. Weaver Power Company has ordered a three-phase, alternating-current generator of normal 1200 horse-power capacity to be delivered by October 15. This will double the capacity of the present plant. President Weaver considers that the French Broad River, on which the plant is located, is one of the best streams in the country for generating power on account of the uniformity of the flow.

GRAHAM.—The town authorities have decided to replace the present street lights and water tanks by an up-to-date system of electric lights and water works. They have contracted with the Southern Service Corporation, of Washington, D. C., to have put up 20 or more arc lights, aggregating 40,000 candle-power, and 30 fire hydrants for the town, at a cost of $2400 a year. Private parties will be supplied at proportionate rates.

NORTH DAKOTA.

LARIMORE.—Mr. E. L. Ross has resigned his position as superintendent of the Larimore electric light plant.

LAMOURE.—The city is considering the advisability of constructing an electric light plant to be operated by the town.

RUGBY.—Mr. L. W. Cornelius has resigned his position as superintendent of the lighting plant of this city, which has been sold to John Kain, of Devils Lake.

GRAND FORKS.—The Grand Forks Gas & Electric Company has recently made about $20,000 worth of improvements, having enlarged its plant which is now housed in a new building and installed an almost entire new equipment of machinery.

OHIO.

ST. PARIS.—Mr. M. N. Beymer is in charge of the municipal lighting plant as superintendent.

TOLEDO.—Mr. E. B. Yanyan is now superintendent of the Toledo Heating & Lighting Company.

SHELBY.—The voters of Shelby have defeated the proposition to raise $10,000 additional to rebuild the electric light plant.

STEUBENVILLE.—The Steubenville Iron Works contemplate installing a new 800-kw. engine-generator unit in its electric plant.

TOLEDO.—The contract for building an addition to the power house of the Toledo Railways & Light Company has been awarded Bentley & Sons at $30,000.

HILLSBORO.—The Hillsboro Light & Fuel Company has increased its capital stock from $40,000 to $52,000. Mr. I. McD. Smith is president of the company.

BUCYRUS.—Reports are to the effect that the Bucyrus Gas & Electric Light Company has passed into the possession of James Finley, of Pontiac, Mich., in consideration of $100,000.

BELLEVUE.—The proposition to bond the city for $40,000 for the construction of an electric light plant was defeated at a recent election of the citizens. It is probable that the contract with the Bellevue Light & Power Company will be renewed.

BELLEVUE.—Mr. G. Cathcart has succeeded Mr. C. M. Lewis as superintendent of the Bellevue Light & Power Company. The company reports a healthy increase of patrons on its residential and commercial lighting circuits and contemplates adding a day load.

VERSAILLES.—The municipal electric lighting plant is in the market for about 500 feet of insulated wire and one, possibly two, direct-connected generators for the power house; also a vacuum pump for the water works. Mr. A. E. Waymire is superintendent and chief engineer and electrician.

HARRISON.—J. P. Hornaday & Co., of Cincinnati, have purchased for Cincinnati and Cleveland (Ohio) capitalists the water works and electric light plant of this city. The Harrison Light & Water Company completely controls all the public utilities of Harrison, both on the Indiana and Ohio sides of the line.

SEBRING.—The City Light & Power Company proposes to increase the capacity of its plant shortly. The company's officers are as follows: President, George E. Sebring; vice-president, E. H. Sebring; secretary and treasurer, W. H. Sebring; manager, Fred Sebring; superintendent, W. M. Murphy; chief electrician, S. E. McKee.

NEWARK.—W. G. Taafel, general manager of the Citizens' Electric Light & Power Company of this city, recently committed suicide by throwing himself in the Licking River. He was receiver for the Newark Savings Bank and became despondent because of financial matters. He left a note saying he was innocent of any wrong-doing in connection with the bank. Mr. Taafel was at one time a machinist, but at the time of his death was one of the leading business men of the town.

OKLAHOMA TERRITORY.

TONKAWA.—It is reported that an electric lighting plant may be established at this place.

KINGFISHER.—Mr. J. L. Bowers is superintendent and chief engineer and electrician of the municipal lighting plant.

OKLAHOMA CITY.—A charter for twenty years has been issued to the Le Clair Electric Company, composed of L. A. Le Clair, B. F. Leggett and Charles Edward Johnson. The company's capital stock is $10,000 and its principal place of business will be in this city.

OREGON.

PHILOMATH.—Mr. A. Horning is making arrangements to construct an electric light plant here in the next few months.

ENTERPRISE.—The local electric light plant, owned by Mr. J. F. Johnson, has been completely destroyed by fire. The loss is estimated at $5000.

WESTON.—The City Council has granted a franchise for the establishment of an electric light and power system to the Preston-Par Milling Company.

SALEM.—The Citizens' Electric Light & Traction Company, of Portland, has purchased the local electric plant and expects soon to make extensions to its railway system.

MEDFORD.—The Medford Electric Light Plant, formerly owned by Mr. R. A. Proudfoot, is now operated by the town as a municipal plant, and Mr. F. F. Loder is superintendent.

PORTLAND.—The directors of the Lewis and Clark Fair have awarded the contract for light

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and power during the Exposition period to the Portland General Electric Company for $82,000.

NEWBERG.—Mr. C. J. Edwards, proprietor of the local electric lighting plant, is preparing to increase the capacity of his lines and will install transformers to reduce the current to the proper voltage for use.

ASHLAND.—The Ashland Electric Power & Light Company expects to install soon a 200-kw. generator and a 300-h.p. water wheel. The company is controlled by the Siskiyou Electric Power Company, of Yreka, Cal., the plant here being in charge of Mr. J. W. Potter, superintendent.

MARSHFIELD.—Messrs E. C. Drews and E. Riggs are reported to be contemplating the establishment of an electric light and telephone system. Mr. Drews was formerly manager of the Sunset Telephone Company for Whitman County, which position he recently resigned to engage in the present enterprise.

PORTLAND.—Messrs. G. W. Waterbury, C. W. Miller and E. D. Whitney have incorporated a power, light and heat company here. They represent Chicago capital and propose to erect a large power plant about 25 miles from Portland near Mount Hood on the Sandy River. The company is capitalized at $100,000.

PENNSYLVANIA.

BOLIVAR.—The Electric Light, Heat & Power Company is building a new plant.

ALLEGHENY.—The council of this city has authorized the issuance of $40,000 electric light bonds.

OAKDALE.—The plant of the Oakdale Electric Light Company has been sold to Mr. W. J. Brown, of this city.

HYNDMAN.—The Hyndman Electric Light, Heat & Power Company is considering the installation of a new engine.

STRASBURG.—Mr. L. J. Blair, proprietor of the electric lighting plant here, is installing a small steam engine and boiler.

HONESDALE.—A new 300-h.p. water heater is being installed in the plant of the Honesdale Consolidated Light, Heat & Power Company.

BELLEVUE.—The Ohio Valley Electric Company, of this place, is now owned by the Allegheny County Light Company, of Pittsburg.

SOMERSET—The Town Council is stated to have granted James M. Coyer, James McKelvey and Fred Biesecker a franchise for an electric light plant.

AVOCA.—The Standard Electric Light, Heat & Power Company is enlarging its electrical and steam equipment and making extensions to its service lines.

SEWARD.—The Seward Heat, Light & Power Company has been incorporated with a capital of $5000. Messrs. D. B. Anderson, Alex. Kerr and Bert Wagner are the directors.

COATESVILLE.—The Consumers' Electric Light, Heat & Power Company has nearly completed the erection of its new plant and it is expected to be in operation very shortly.

McKEESPORT.—The ordinance recommended by the Finance Committee of the Council providing for an issue of $125,000 bonds to be used for the construction of a municipal electric light plant, has been passed.

NICHOLSON.—The following are the officers of the Nicholson Light, Heat & Power Company: President, F. E. Platt; secretary, James G. Sanderson; treasurer, manager and superintendent, Moses Shields, Jr.

SHICKSHINNY.—Mr. Briggs has resigned his position as superintendent of the electric light plant here to accept a similar position with the Irondale Electric Light, Heat & Power Company, of Bloomsburg, succeeding Mr. W. O. De Witt.

VANDERGRIFT.—The following officers have been elected by the Vandergrift Electric Light & Power Company: President, E. W. Pargey; vice-president, S. A. Davis; secretary, Joseph Murphy; treasurer, H. W. Pratt; purchasing agent, J. F. Horn; consulting engineer, A. Pinkerton.

WILLIAMSPORT.—The contract for lighting streets and engine houses for ten years has been awarded to the Lycoming Electric Company for 221 arc lights at $60 per light per year, $18 per light per year for incandescent lights, and for light in engine houses and city hall 10 cents per kilowatt-hour.

BLOOMSBURG.—Mr. W. O. De Witt, formerly superintendent of the Irondale Electric Light, Heat & Power Company, has accepted the superintendency of the new plant being erected for Mahanoy City and Shenandoah by the People's Electric Light, Heat & Power Company. He is succeeded at Bloomsburg by Mr. Briggs.

HATBORO.—The Hatboro Electric Light Company, formerly owned by Smith & Davis, has been incorporated with a capital stock of $25,000. The following are its officers. President, A. J. Smith; vice-president, H. L. Chandler; secretary and manager, W. W. Wilgus; treasurer, C. L. Leland; chief engineer and electrician, William Evans.

LORETTO.—The City Council has under consideration an offer of $1,000,000 from Mr. Charles M. Schwab, the amount to be expended in improvements in the town, where Mr. Schwab spent his boyhood. The improvements will include the paving the streets and the erection of an electric light plant and water works; a complete system of sewer and water pipes will also be laid.

HALLSTEAD.—The Union' Electric Company has been consolidated with the Susquehanna Electric Light & Power Company under the style of the Susquehanna County Electric Company. The latter company is capitalized at $100,000 and is officered as follows: O. S. Johnson, president; F. J. Platt, secretary, treasurer and manager; John K. Harris, superintendent and chief engineer and electrician. Besides lighting Hallstead, the company's generating plant furnishes lighting current to Great Bend, where it is distributed through a sub-station equipped with two 50-kw. 6000/1000-volt transformer and one constant-current transformer.

CHARLEROI.—The People's Electric & Manufacturing Company has been absorbed by the Monongahela Valley Electric Company, which has a capital stock of $100,000 and the following officers: President, Robert J. Linton; secretary, treasurer and manager, John L. Redinger; superintendent, G. P. Lysinger. Lighting current is furnished to California, Allenport, Fayette City, Bellvernon, North Bellvernon, Monasson and Speers. The company is considering increasing and improving its equipment; the new machinery will include 300-h.p. boilers, one arc machine, a direct-current power generator, 600-h.p. engines, and the necessary accompanying apparatus.

PITTSBURG.—Mr. Charles E. Warner, formerly general superintendent of the Allegheny County Light Company, of this city, has been appointed general manager of the San Juan Light & Transit Company, which operates an extensive electric lighting and traction system in the capital of Porto Rico. Mr. Warner is a western man, having been engaged at one time in practical work in railway and lighting construction in New Westminster, Vancouver, Nanaimo and Portland. He was also manager of the Northwestern agency of the Westinghouse Electric & Manufacturing Company in Tacoma, Wash., for five years from 1893 to 1898. During this time he also had charge of the surveys and development work on the White River power project, one of the largest hydraulic-electric power enterprises in the Northwest.

RHODE ISLAND.

BRISTOL.—The Bristol County Gas & Electric Company is now controlled by the Narragansett Electric Lighting Company, of Providence. Mr. Marsden J.' Perry, of Providence, is manager of the plant and Mr. W. I. Barnes is superintendent.

WESTERLY.—The arrangements of the Westerly Gas & Electric Light Company for putting in a power circuit to supply day power for motors, fan motors and day electric lights, have been completed and the circuit is now in operation. The company has also completed its work of stringing new wires for more electric lights at Watch Hill.

WESTERLY.—The People's Light, Heat & Power Company, of Westerly, which recently took over the Mystic Electric Light & Power Company, has completed arrangements for the absorption of other corporations. It has acquired the Pawcatuck Valley Street Railway Company, the South Shore Gas & Electric Company, and the Westerly & Hopkinton Railway Company. The Railway & Lighting Company now has a monopoly of the electric lighting business in the Rhode Island village of Westerly and the Connecticut villages of Pawtucket, Stonington, Mystic and Noank. The corporation already has 6 miles of street railway in operation and 7½ miles in the course of construction.

SOUTH CAROLINA.

FORT MILL.—The directors of the Catawba Power Company at a recent meeting decided to increase the capital stock of the company from $750,000 to $850,000.

GEORGETOWN.—The Georgetown Electric Company is installing an additional 60-kw. alternator, making in all three units of this kind now in operation in the plant.

ABBEVILLE.—The Abbeville Water, Light & Power Company has under consideration extensive improvements at its plant, which include a new power house and the installation of a storage battery, insulator, engine, boiler, etc.

NEWBERRY.—The commissioners of public works of Newberry have purchased the new electric lighting plant for the city. The purchase was made from the General Electric Company, Schenectady, N. Y. The new plant will be installed within the next few months. The purchase price of the new system was $5905.

BELTON.—The previously mentioned Belton Power Company has been granted a charter by the Secretary of State. The company's capital is $100,000, and arrangements have been completed for the establishment of a large electric power plant in this city. About 5000 horse-power will be developed from the flow of Saluda River and transmitted to Williamston for the operation of cotton mills. Electric lights and water will also be furnished to Belton.

SOUTH DAKOTA.

STURGIS.—The plant of the S. A. Oliver Electric Light Company, which furnishes light for this city and Fort Meade, has been enlarged by the addition of two 200-h.p. boilers.

TENNESSEE.

SPRINGFIELD.—Bids for the construction of a water works system and an electric light plant have been advertised for.

JEFFERSON CITY.—The Jefferson City Electric Company is considering changing over from water-power to steam as a means of operating its plant.

DYERSBURG.—Mr. H. F. Goostreet is superintendent of the city electric lighting plant. All current is sold by meter at 10 and 15 cents per kilowatt-hour.

MURFREESBORO.—Mr. J. H. Nelson, who owns the electric light plant of this place, expects to substitute next year arc lamps for the present street incandescent lights.

MORRISTOWN.—Mr. J. F. Mathes has been appointed superintendent of the city electric light plant, with Mr. John Stephens as chief engineer and Mr. W. H. Akers, assistant engineer.

SARDIS.—A charter has been issued to the Sardis Electric Company, recently organized, with a capital stock of $25,000. The incorporators are D. L. Rush, W. R. Roberts, W. H. Harvey, L. L. Pearson and Rhea P. Carey.

NASHVILLE.—The proposed water-power electric plant for this city is assured by the statement that Meikelham & Dunsmore, of New York City and C. H. Ackerman, of Binghamton, N. Y., have arranged for the placing of $100,000 of stock and the disposal of $4,000,000 of bonds of the Great Falls Power Company. This company is promoted by C. H. Fisk, of Detroit, Mich.

TEXAS.

DUBLIN.—The Dublin Light & Power Company announces that it is in the market for a new 100-h.p. boiler.

SULPHUR SPRINGS.—A new 120-kw. generator, direct-connected to a 150-h.p. engine, will be

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installed in the electric light plant owned by B. T. Ashcroft & Sons.

LUFKIN.—The Lufkin Light & Power Company is composed of Hackney & Henderson. Mr. J. S. Henderson is manager of the plant, and Mr. F. M. Stephens is chief electrician.

GROESBECK.—J. C. Anglin & Company own and operate the electric light plant here. J. C. Anglin is manager and purchasing agent; John Berkeleyl, superintendent, and J. F. Brown, chief engineer and electrician.

BLOSSOM.—Blossom is to be lighted by electricity supplied by an electric light plant which is to be installed in the mill of the Blossom Oil & Cotton Company. The necessary machinery has been purchased and it is expected to have the plant in operation some time this month.

AUSTIN.—Mr. F. H. Brun has been appointed superintendent of the city water works and electric light and power plant; Mr. Walter F. Johnson is chief engineer, and Mr. George Fegel, Jr., chief electrician. The city also controls the Austin Water, Light & Power Company.

ARLINGTON.—The Arlington Light & Power Company has been organized and incorporated with a capital stock of $10,000, for the purpose of installing and operating an electric light and power plant. Messrs. A. W. Collins, William Dugan, W. L. Sweet, E. A. Hood and W. Weeks are named as the incorporators.

BAY CITY.—The Bay City Ice, Light & Power Company, which was organized not long ago with a capital stock of $50,000, now has its plant in operation. The following are the officers: President, I. Marks; vice-president, Henry Blethen; secretary, general manager and purchasing agent, J. H. Craig; treasurer, Henry Rugeley; chief engineer and electrician, William Fries.

SAN ANGELO.—The Concho Water Power Company has just completed a large wing dam on the South Concho River. The dam, which is built of stone and concrete, has cost in the vicinity of $2500. The total length of both wings is 500 feet. This gives a spillway of twice the width of the river. A mill race 700 feet long leads to three turbine wheels. These will supply power for lighting the city and for pumping the city's water supply.

UTAH.

RICHFIELD.—Several local capitalists propose building an electric light and power plant here in the near future.

SALT LAKE CITY.—The Utah Light & Railway Company has let the contract for building a transformer station near its plant on the Jordan River at a cost of $15,000.

SALT LAKE CITY.—Mr. W. S. McCornick, a wealthy banker of this city, is said to have purchased the plant and property of the Salt Lake City Water & Electrical Power Company located at the Jordan Narrows.

AMERICAN FORK.—The Utah County Light & Power Company, of this city, is considering a proposition to light Salt Lake City with power from American Fork Canyon. For this purpose it is intended to erect a plant of about 1000 horse-power capacity 1½ miles above the present plant.

VERMONT.

MONTPELIER.—A new 200-h.p. generator is being put in at the Pioneer steam plant of the Consolidated Lighting Company to run the Barre & Monteplier Street Railway direct from the power station.

BENNINGTON.—The Bennington Water Power & Light Company may change its street lighting system from direct-current series arc to alternating-current constant-potential. Tub transformers will be used.

BURLINGTON.—The council has advertised for bids for furnshing labor, material and the necessary equipment for installing a complete electric plant in this city, the plant to have a capacity of 250 kilowatts.

VIRGINIA.

HOLLAND.—A franchise has been granted to local parties for the construction and operation of an electric light plant.

MARION.—The Marion Light & Power Company is building a new dam in order to increase the capacity of its plant, and will soon place an order for a new three-phase 60-cycle dynamo.

NORFOLK.—The People's Light, Heat & Power Company is being organized here and will apply for a franchise to operate an electric light and power plant. The company will have a capital of $100,000.

RICHMOND.—An ordinance has been introduced in the council providing for a bond issue of $300,000, the money to be used in the construction of an electric light and power plant on the site of the old pump house.

LYNCHBURG.—The Lynchburg Traction & Light Company is building a new 4000-h.p. water power station for the transmission of electric power. It is expected to have the new line in operation by December 1, this year.

SUFFOLK.—The Suffolk Light & Ice Company has elected the following officers: President and manager, G. W. Fruitt; vice-president, G. C. Guvernator; secretary and treasurer, R. J. Brinkley; chief engineer and electrician, A. E. Harvell.

FRONT ROYAL.—Recorder W. J. Kendrick writes that the contract for the electric light machinery to be installed in the new municipal plant now in course of construction has been awarded to the Rumsey Electric Manufacturing Company for $5000.

NORFOLK.—The Williams interests, controlling the Norfolk Railway & Light Company, will, it is said, expend $500,000 in new heating and ice plants. The company has met with great success in disposing of electric power and is now working out plans for greatly extending its interests.

ALEXANDRIA.—The council has granted to Charles F. Thompson a franchise for an electric light and power plant, in consideration for which he proposes to pay the city a bonus of $10,000, to take over the present light plant at $3500, to furnish the city with 39 or more arc lights for the streets, etc., at $76 per annum each, and to give bond that the work shall be begun in six months and completed within a year.

WASHINGTON.

CASTLE ROCK.—Mr. John Leffler has been appointed manager and superintendent of the plant of the Castle Rock Electric Company.

CHEWELAH.—D. Van Slyke and D. F. Strobeck are reported to have secured a franchise for an electric light plant and water works.

HARRINGTON.—Mr. H. W. Fellows, an electrical engineer of Spokane, contemplates establishing an electric lighting plant in this city.

GREENWOOD.—The owners of the Providence Mine here are planning to install a complete electrical system at the mine, power for which will be furnished by the Cascade Power Company.

PROSSER FALLS.—The Prosser Falls Electric Company is contemplating installing electric light and power plants in Mabton and Sunnyside.

ELMA.—George A. Avery and Charles Anderson, of Olympia, have secured a 25-year franchise for the operation of an electric light plant.

SEATTLE.—The Moseley-Yates Lighting Company has been incorporated with a capital of $100,000 by Messrs. J. H. Yates, of Spokane; Hiram W. Moseley, Edward M. Cox, John H. Corcoran and H. M. Herrin.

SPOKANE.—The Spokane Water Power Company is developing 14,000 horse-power at the lower falls. With this it will light the city, run the street car system and transmit 1800 horse-power to the mines in the Couer d'Alenes district. The company is also preparing to build an electric line to Medical Lake over the old right of way of the Seattle, Lake Shore & Eastern Railroad which was recently acquired.

SEATTLE.—The great steel receiving tank, made in Pennsylvania for the Cedar River municipal light and power plant, is now at hand. This is the last piece of apparatus to be installed, and with this in place, all that remains to be done to complete the system is the completion of the pole line. The tank will receive the water from the dam 604 feet above, whence it will be sent to the water wheels. The engineer in charge of the work states that it is expected to have the plant in operation some time in October.

WEST VIRGINIA.

NEW CUMBERLAND.—Press reports state that the City Council has considered favorably the plans of Engineer W. J. Miller, of Wheeling, for water works and an electric light plant.

WISCONSIN.

SHEBOYGAN.—The Sheboygan Light, Power & Railway Company is preparing to spend about $37,000 in rewiring its system.

LADYSMITH.—The Ladysmith Light & Power Company is now engaged in the development of water power 4½ miles south of here on the Flambeau River.

SPRING VALLEY.—The Village Board has adopted plans and specifications for a municipal electric lighting plant to cost about $10,000 and to be completed this fall.

VIROQUA.—The Viroqua Electric Light Company expects to add a 75-h.p. Corliss engine and a 50-kw. alternating-current generator to its plant equipment before the year is out.

MILWAUKEE.—Local press reports are to the effect that the Finance Committee has formally approved the issue of $150,000 bonds with which to construct an electric light plant.

RICHLAND CENTER.—The plant of the Richland Center Light Company, which was owned by G. H. Strang, has been turned over to the city and will be operated in the future as a municipal plant.

MILWAUKEE.—The Milwaukee Electric Railway & Light Company has been granted a permit to erect a $100,000 addition to its Commerce Street plant. The addition will be four stories high and 83 x 144 feet.

CLINTONVILLE.—The Clintonville Electric Light Company is about to enlarge its power house and will install a duplicate set of equipment as soon as the extension is completed. Mr. H. H. Cole is superintendent.

RHINELANDER.—The Rhinelander Power Company has about ready its plans for the dam and power house to be constructed at Hat Rapids. The structure will probably be of concrete with steel bulkheads and steel beams.

NEW RICHMOND.—By the breaking of a piece of machinery recently in the municipal electric light plant in this city the plant was badly wrecked. One of the dynamos was completely destroyed and other machinery and apparatus about the plant was broken.

SPRING GREEN.—The electric light plant of this place, formerly owned by G. F. Post, has been operated as a municipal plant since June of this year. It is stated that meters, new transformers and No. 0000 wire, to the amount of $1200, will be installed shortly.

APPLETON.—The plants of the Fox River Valley Gas & Electric Company at Appleton, Neenah and Menasha are said to have been sold to the Wisconsin Traction, Heat, Light & Power Company for $600,000. The deal gives the Wisconsin company complete control of the lighting facilities of Appleton and the twin cities.

WAUSAU.—The city has recently accepted a proposition from the Wausau Electric Company to furnish the city with current for street lighting purposes at the rate of 2.3 cents a kilowatt-hour, or approximately $29.75 per lamp per annum on the basis of an all-night schedule. The city is to own and operate all pole lines and lamps, which, it is said, will bring the cost up to $45 per lamp per annum. This is probably about as good a figure as any municipality can boast of for its lighting service. The series-enclosed alternating system is to be used, a constant-current lamp operating an 6.6 amperes being chosen. The buying of current by the city by the watt-hour but still operating its own system of lamps is somewhat unusual, it being the general practice to either build a municipal plant or else pay a stated amount to an operating company, the latter owning the complete system.

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AN INTERESTING FRENCH STEAM-DRIVEN TURBINE PLANT.

THE POWER STATION AT NEUCHATEL.

Power plants which are designed for the supply of electric energy from turbo-generators (hydraulic) are often forced to add a reserve equipment in the shape of steam engines. For example, in the plant at Zurich with 600 hydraulic horse-power there is, in addition, a steam plant of 2800 horse-power. At Chaux-de-Fonde, with 1000 hydraulic horse-power there is 600 horse-power in gas engines, and at Lausanne, with about 1000 hydraulic horse-power there is 1200 horse-power in the steam plant. For several years it has been apparent at Neuchatel that the power furnished by the Areuse was not sufficient for the development and growth of the distribution system established by the town in 1895 and 1896. The power house near Boudry utilizes a fall of 56 meters (183.7 feet) and is equipped with six turbines of 300 horse-power each, requiring for the production of 1500 horse-power 2700 liters (95.3 cubic feet) of water per second, and the demand from the station constantly approaches this figure.

The Areuse furnishes at low water in the neighborhood of 1600 liters (56½ cubic feet) per second, and this is further reduced by the demands of successive power stations along its course, so that the actual flow may vary between 1000 and 2000 liters (35 and 70 cubic feet) per second in a very irregular manner in the course of a single day. The design of the new power house required considerable time on account of the difficulty in choosing a site. After much discussion, a strip of ground owned by the town upon the Quay de Champ Bougin was decided upon. The location is most excellent, easy of access, and the lake furnishes the necessary water; the value of the site being the cause of hesitation.

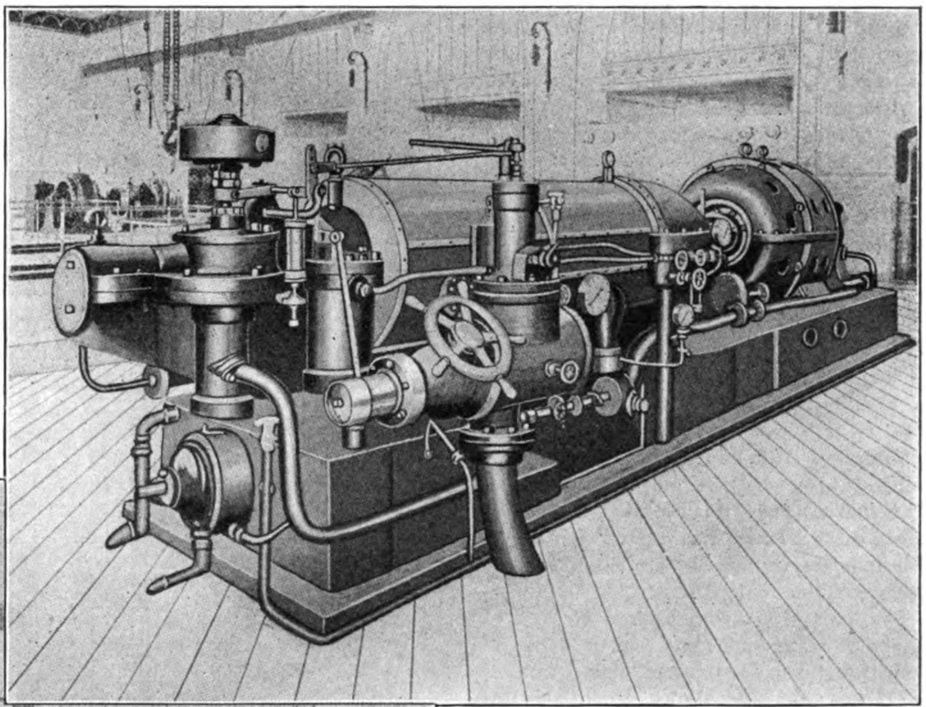

FIG. 2.—TURBO-GENERATOR AT NEUCHATEL.

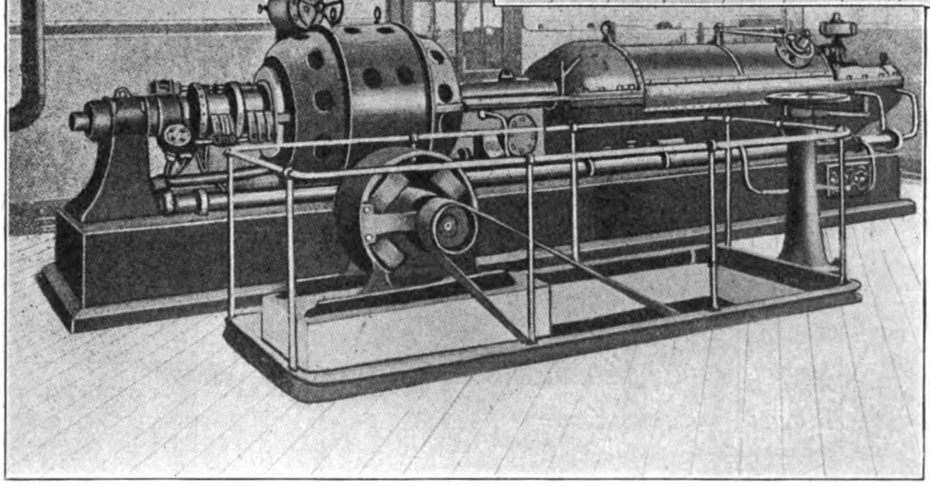

FIG. I.—TURBO-GENERATOR SHOWING MOTOR FOR OPERATING CONDENSER.

The two electric railways of the town were receiving their current from two transformer stations belonging to two companies. The fusion of these companies and the development of their system rendered an increase in the capacity of these stations necessary. The town has acquired one of these installations and has made arrangements with the company to deliver direct current, including in its charge the cost of transformation and generation. The choice of steam as the source of thermal energy has been dictated by the first cost and the facility with which it may be used. A short study was made of gas engines, which are in vogue at the present time on account of their economy in the use of combustible, and the results of this study differ in no way from those obtained in similar cases. The towns of Chaux-de-Fonde and Bale, which have installed gas engine plants, seem almost ready to abandon their use.

thus justifying the decision in the present case. The choice of steam turbines was, moreover, imposed by the first site decided upon, and this choice has since been confirmed by a careful comparison with reciprocating engines.

The building is designed for six boilers, each with 2475 square feet of heating surface; four steam turbines of 300 kilowatts each; three rotary converters of 300 kilowatts each, and three converters of 65 kilowatts each. The power house was built with great rapidity. The excavation for the foundation consisted of 3000 cubic yards, of which 2220 cubic yards were in rock. In spite of autumn rains, the building was covered three months after work was begun. The foundations rest entirely upon rock. The excavation was rendered difficult by the presence of a constant sheet of water, and owing to the slight difference in level between the foundations and the lake drainage was rendered troublesome.

Two plans of roof construction were considered, one of steel and brick costing $3700 and the other of armored concrete costing $3500, the latter being used. The preference was given to this latter construction principally on account of the fact that it allowed the greater part of the cost to be expended in the surrounding country, instead of giving out the work to contractors at a distance. The calculation and the working plans for the concrete work were made at Lausanne, according to the patents of Hennebique, and some serious mistakes were made. Portions of the ceiling had to be torn down and reconstructed and other portions reinforced by means of iron plates. The ceilings are covered with asphalt 2 centimeters (0.7874 inch) thick, upon which is placed a covering of slag 20 centimeters (7.8 inches) deep, this covering having the effect of protecting the interior from outside temperature and the asphalt from sudden variations of heat and cold.

The floor of the engine room consists of blocks of white sandstone laid on a bed of asphalt. It has been tested with a tension of 35,000 volts and shows remarkable insulating qualities. The cable ducts are covered with white marble. The lighting of the interior is perfectly assured by the lateral windows. The cost of the building was $24,600, to which must be added: Foundations and masonry for boilers, $2760; chimney, foundation and accessories, $4740; flue, $1035; foundations for machines, foundations in the basement, ducts, masonry and auxiliaries for carrying the cables, $1825; furniture, $80; shed, $315; making a total of $35,355.

The chimney is 55.4 meters (181 ft. 9 ins.) high, with an internal diameter of 3 meters (9 ft. 10 ins.) at the base and 2 meters (6 ft. 6¾ ins.) at the top. It has an ornamental brick top, which relieves the monotony of the structure and was built by the firm of Walzer, of Winterthur. The two boilers are of the water tube type, and have 2180 square feet of heating surface each and furnish steam at a pressure of 12 atmospheres (176 pounds). A superheater with 688 square feet of heating surface is placed under the steam drum in the path of the gases. The water tubes are 140 in number, 3¾ inches in diameter, and are fixed between two rectangular water chambers, one of which is connected with a drum 59 inches in diameter and 22 feet 9 inches long; the drum is normally half filled with water. Sheet iron divisions direct the circulation of the water, so that the two

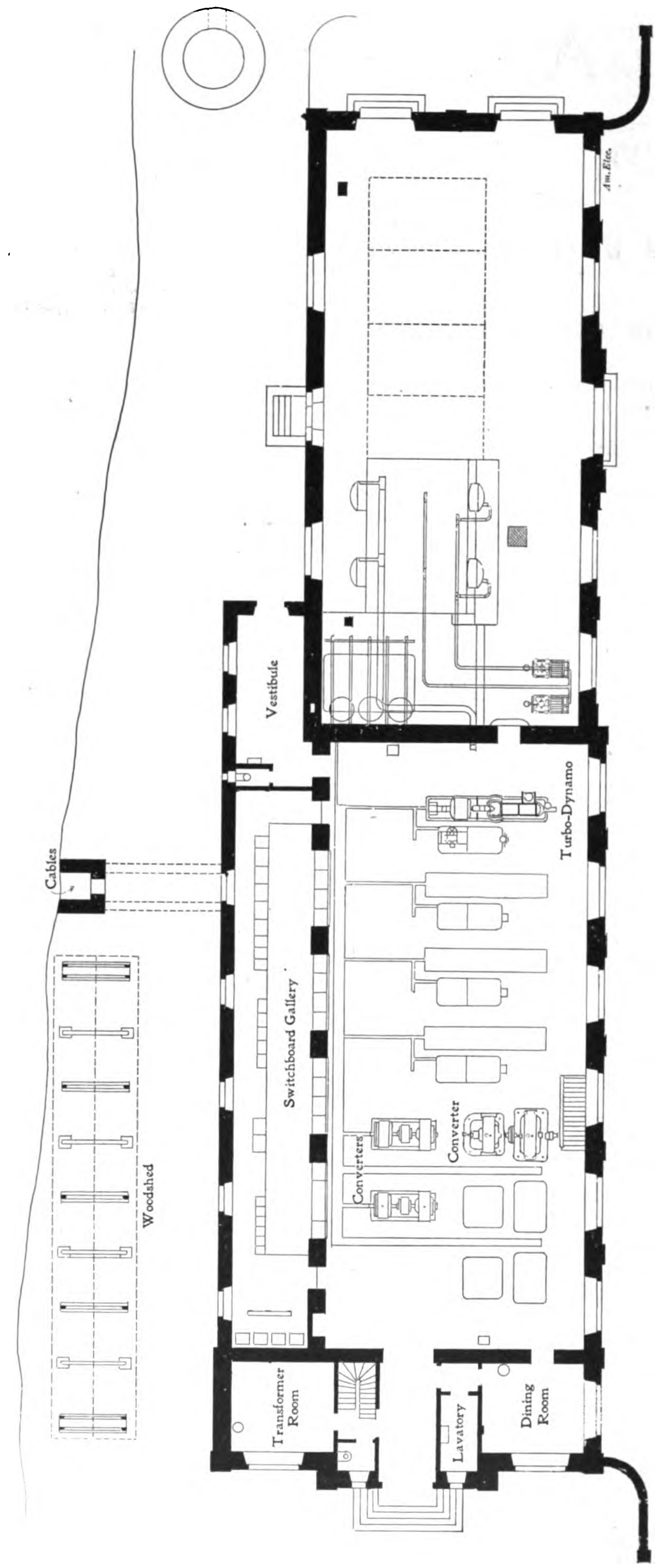

FIG. 3.—PLAN VIEW OF THE GROUND FLOOR.

upper rows of tubes have a descending current and the others an ascending current. The tubes are expanded into the headers, as is customary in this type of boiler, and the joints are removed from the direct path of the gases. The grates have a surface of 48.2 square feet and the normal steam production is 2.46 pounds per square foot of heating surface, with an evaporation of 8.1 pounds of water per pound of coal of 13,400 B.T.U. calorific value. The effect of the superheater is very pronounced at forced loads, 50° Centigrade of superheat being easily obtained; under light loads the superheater hardly does more than dry the steam.

The steam drum contains about 6 cubic meters of water, the total capacity of the boiler being 12½ cubic meters when the water level is up to the middle of the drum. This relatively large volume for a water-tube boiler renders its operation particularly simple. A longitudinal section of this boiler, showing the arrangement of the interior, the location and arrangement of the superheater and the flue, is shown in Fig. 4. The illustration also shows the arrangement for a steam jet which may be added at some future time. As the chimney is designed for six boilers, the draft is very intense for two, and, therefore, the construction of the masonry work necessary for artificial draft is a provision for future growth. Owing to the length of the grates (2 meters) it is very easy to render the fires smokeless if properly handled, but unfortunately there are few firemen who are familiar with the proper method of firing to produce this result.

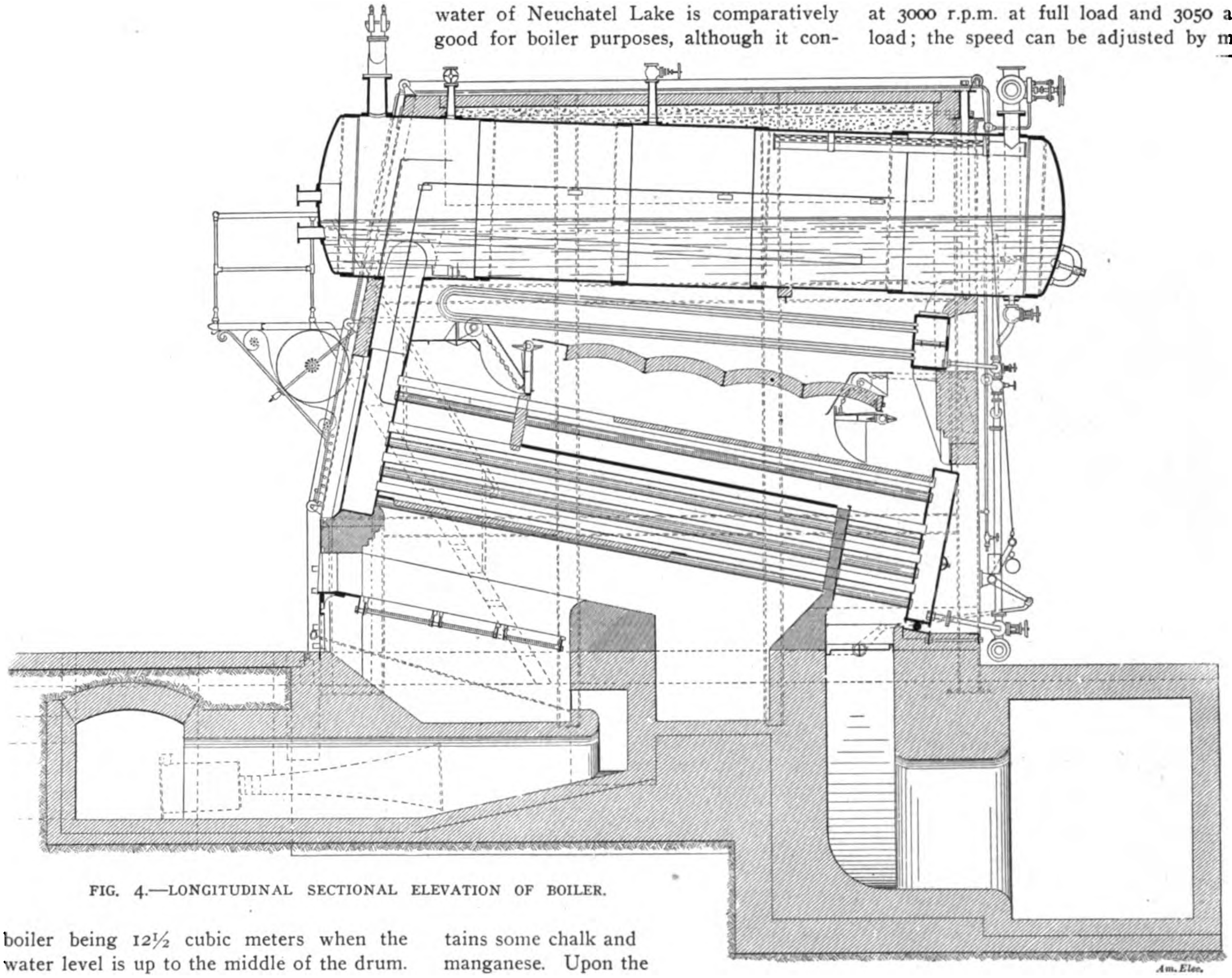
FIG. 4.—LONGITUDINAL SECTIONAL ELEVATION OF BOILER.

Am. Elec.

The boiler is provided with a damper by means of which the gases passing in contact with the superheater may be regulated or shut off entirely. With practice in preparing the fire and with the superheater shut off, the boiler may be brought up to pressure from a cold condition in twenty-five minutes without producing any bad effects, and in practice with an ordinary fire of wood or oil this can be accomplished in little more than an hour. The headers in which are terminated the 140 boiler tubes are made of cast steel without any rivets, and the interior of the tubes is accessible for cleaning purposes by the removal of the usual type of cover. The water of Neuchatel Lake is comparatively good for boiler purposes, although it contains some chalk and manganese. Upon the advice of experts who have examined the conditions, Rossel purifiers, furnished by the Mechanical Construction Society, of Bale, have been installed. These consist of a raised reservoir, with a capacity of 706 cubic feet, into which the water from the lake is pumped by means of a rotary pump operated by an electric motor. Below the reservoirs are the purifiers, consisting of three chambers of 88¼ cubic feet each, in which the water is allowed to stand from one-half to two hours and in which is placed 10.6 ounces of carbonate of soda. By a special pipe, water from the bottom of the boiler may be added in order that the small quantity of precipitated carbonate may be utilized. The purified water is then led into a small reservoir, divided into two parts separated by a filter. The feed pumps take the water from this after it has passed through the filter. Up to the present time no deposit has been found in the boiler tubes. The feed water enters the boiler at the bottom of the drum, as shown in the illustration. The mixture of water and steam which comes from the boiler tubes is projected horizontally upon a casting pierced with openings by which the water is separated. Steam leaves the drum at the top through a perforated longitudinal pipe, and thence enters the superheater.

The turbo-generator was built by Brown, Boveri & Cie., and has a capacity of 300 effective kilowatts with steam at 162 pounds pressure at the throttle. The turbine runs at 3000 r.p.m. at full load and 3050 at no load; the speed can be adjusted by means of the regulator through a range of 10 per cent. The steam turbine is of the Parsons type, as shown in Fig. 2. The lubrication is practically the same as that of English turbines. The oil is delivered under moderate pressure into a circular canal between the interior bearing and the axle. The oil pump is operated by a countershaft geared to the axle of the regulator, and draws its oil from a reservoir placed in the basement, through which a circulation of cold water is kept up. The temperature of the oil does not exceed 40° Centigrade.

The regulation of the amount of steam cannot be effected by reducing the section of the first chamber, so that it is necessary to arrange for throttling the entrance.

The difficulties of regulating under these conditions and the ingenious solutions proposed to accomplish the result are well known. Mr. Parsons has adopted an oscillating valve, the center of oscillation varying according to the position of the governor. The valve is oscillated by an eccentric mounted upon the shaft of the governor or upon the shaft of the oil pump. The number of oscillations varies with different types, it being 120 per minute at Neuchatel. At each oscillation, due to the play of the valve, the piston attached to the admission valve is raised a certain distance, the turbine thus receiving puffs of steam at the rate of 120 per minute, the volume being controlled by the governor. An additional regulator, operated by hand, is provided in case of failure of the automatic governor. Attempts have been made to control the speed by means of a solenoid in order to obtain a constant electric pressure with a variable speed. Up to the present time, however, this method has not been adopted by Brown, Boveri & Cie.

The dynamo is mounted on the turbine shaft, of course, and is compound wound, but the shunt and series fields are not superposed, but placed at right angles. The object of this is to avoid displacement of the axle of commutation and sparking at the brushes. The commutator is very long and is provided at the center and either end with a steel loop to resist centrifugal force. The brushes are of curved form. The operation is very satisfactory, without heating or sparking, and without rendering it necessary to move the brushes with variations of load. The only inconvenience of this system is that it requires compound or overcompounded dynamos in order that the voltage may vary with the load.

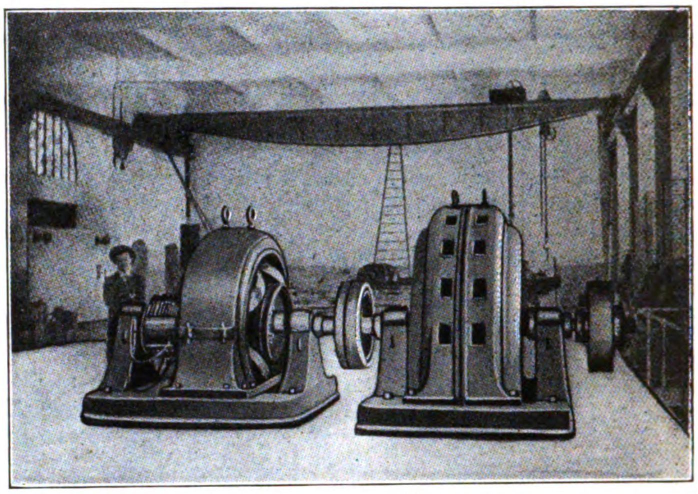
FIG. 5.—250-KW. MOTOR-GENERATOR.

The condenser pump is operated by an independent electric motor located near the turbine and belt-connected to the pump.

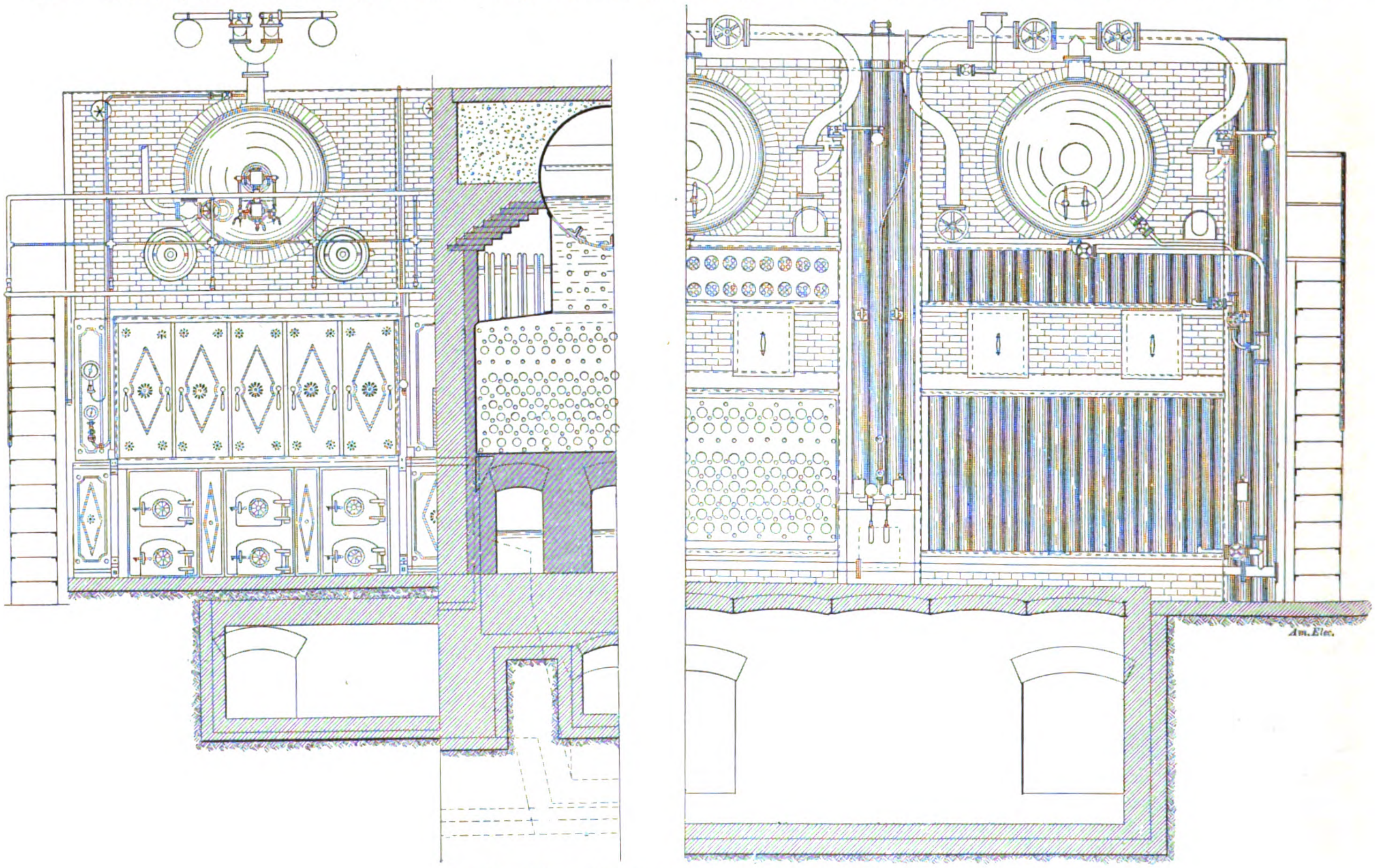

FIG. 6.—FRONT AND REAR ELEVATION OF BOILER.—FIG 7.

The constructors' guarantees are based on the use of dry saturated steam at 162 pounds pressure at the throttle and also on the consumption per effective kilowatt-hour. Under these conditions the guarantees are 24.86 of steam per kilowatt-hour at full load and 27¾ pounds at half load, the temperature of the water of condensation not to exceed 20° Centigrade. Results inferior to these are often found with turbines of the same power. At Coire, with a 200-kw. turbine, using steam at a pressure of 12½ atmospheres and superheated to 250° Centigrade, the tests showed a consumption of 24.14 pounds per effective kilowatt-hour; at Tschopeln a 400-kw. turbine, using saturated steam at 7½ atmospheres, showed a consumption of 23.15 pounds per kilowatt-hour, the guarantee being 26.45 pounds. Two series of tests were made on the machines for Neuchatel, the first at Baden and the second at the power house of Champ Bougin. The figures, reduced to effective kilowatts at full load, are given herein, deducting the energy required for the motor which operates the condenser pump. The test at Baden showed a steam consumption of 23.1 pounds per kw.-hour and at Neuchatel a figure somewhat higher. At Baden, however, more accurate measures were used, the condensed water being measured as it came out of the turbine, all leakage deducted, and a surface condenser used. On the contrary, at Neuchatel, it was necessary to measure the water as it entered the boilers, thus neglecting all the leakage, and the precision of measurement left considerable to be desired. However, this same test having served to verify the guarantees regarding the performance of the boilers, and as these with the employment of a poor quality of fuel have exceeded the guarantees, it is probable that a slight error was made favoring the boilers and to the detriment of the turbines. There was also a second cause for error, due to the fact that the electrical measuring instruments were not absolutely correct. The results of the Baden tests are given below:

290 kilowatts saturated steam, 23.1 pounds per kilowatt-hour.
311 kilowatts superheated steam, 38° C., 21.23 pounds per kilowatt-hour.
140 kilowatts saturated steam, 27.58 pounds per kilowatt-hour.
145 kilowatts superheated steam, 28° C., 25.198 pounds per kilowatt-hour.
No load, dynamo excited, 917.12 pounds per hour.
No load, dynamo not excited, 881.85 pounds per hour.

The last two figures are included in the result to account for the work of condensation, and should add in the neighborhood of 550 pounds per hour, or 10 kilowatts at 55 pounds. To establish these figures the work of condensation, which was not measured, was assumed as 10 kilowatts. At Neuchatel this work was measured and found to be somewhat less than the value assumed, thus serving to make the test at Baden show up even better.

The power furnished by the hydraulic power station at Pre-aux-Clees, near Boudry, is three-phase at 33 cycles per second and 3800 volts. The railroad company had at Neuchatel a small power station which was not used, where it had installed rotary converters. The inconveniences arising from their use, however, were such that in the power house at Champ Bougin motor-generator sets were installed. The power house contains two sets of 100 horse-power each, consisting of a three-phase induction motor operating at 3800 volts and a separately excited dynamo furnishing current at 500 to 720 volts and running at 650 r.p.m. Another set consists of a synchronous motor and generator, the combination having a capacity of 250 kilowatts output. The use of this motor was necessitated by the small size of the feeders entering the power house. All future sets are to be equipped with induction motors.

The plans of the power house show a lateral passage communicating by four large bays with the engine room. In this passage is the switchboard galley, as shown on the plan, containing the distribution switchboard for the three-phase and single-phase, high-tension current and for the direct current at 580 volts. The apparatus which requires manipulation, or the indicating appliances which are continually used, are located in the bays at the side of the room. The conductors which lead from the switchboard and the machines are in lead-covered cables placed in ducts, the floor of the room having been provided with deep trenches covered with white marble slabs. A subcellar is often preferred for the conductors, but the foundation of this power house being of hard rock and difficult to work, and the proximity of the lake rendering it damp, this disposition of the cables has been found more economical. The interior arrangement of the building is clearly shown in the plan.

DECORATIVE LIGHTING AT THE LOUISIANA PURCHASE EXPOSITION.

BY J. R. CRAVATH.

In the creation of a modern exposition two of the most important elements are the work of the architect and the work of the engineer who plans the decorative lighting. The expositions of the past fifteen years have been something more than aggregations of structures housing exhibits. The design and situation of buildings which produced the spectacular effects now so familiar have by public demand become inseparable from great expositions and probably attract as many, if not more, people than the exhibits themselves. After the architect, the sculptor and the landscape gardener have performed their work, a great task still remains for the lighting expert and electrical engineer. The work of the architect and landscape gardener makes the site attractive by day only, but an exposition is demanded that is attractive at night. Great and beautiful though the creations of the architect and sculptor may be, they are as nothing at night until the skill of the illuminating engineer transforms them into palaces of light. Disregarding the architecture which forms the foundation for the decorative lighting, there is no doubt but what the night illumination is directly responsible for more paid admissions to the grounds than any other single feature.

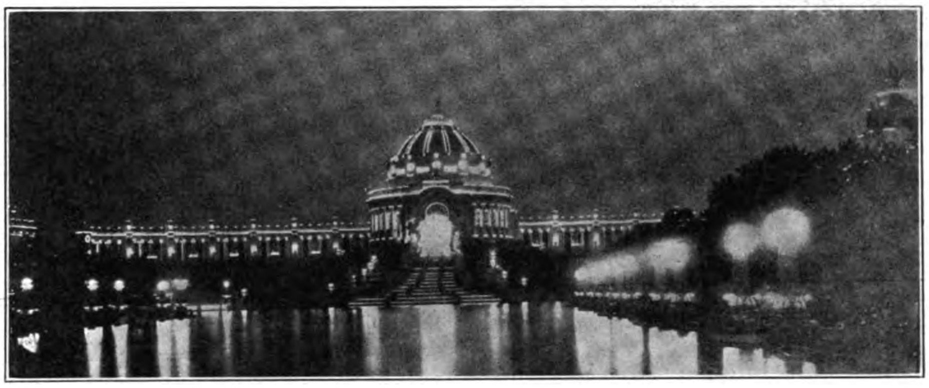

FIG. I.—FESTIVAL HALL AND THE CASCADES.

The decorative lighting of exposition buildings is somewhat of an evolution. Time was when these places were dark and dreary at night, for the reason that there were no means of lighting the building exteriors. Not until the incandescent lamp came into the field has decorative lighting become possible; and not until long after its adoption for commercial use was its value for exposition work sufficiently recognized. The present plan of lighting may be considered as the outcome of the towers of light, etc., seen inside the buildings at earlier expositions.

Although incandescent lamps were used to some extent to outline the buildings at the Columbian Exposition at Chicago in 1893 and at later expositions, it was not until the Trans-Mississippi Exposition at Omaha in 1898 that it was used in the main vistas to the exclusion of all other illuminants. The late Luther Stieringer, whose name was closely associated with the decorative lighting of almost every exposition in this country for twenty years up to and including the Pan-American Exposition at Buffalo in 1901, was for a long time previous to 1898 a firm believer in the exclusive use of the incandescent lamp for purely decorative illumination, but found difficulty in persuading exposition authorities to adopt his views. The incandescent lamp was used at Omaha, however, and ever after. At the Pan-American Exposition a night effect was produced the equal of which had never before been seen.

To Henry Rustin fell the responsibility for planning the decorative lighting at the Louisiana Purchase Exposition at St. Louis. He and his assistant, R. H. Moore, had before them a large undertaking. They had the expositions at Buffalo and at Omaha as guides, but the distances from which the illumination would be viewed were much greater at St. Louis, and the square feet of building surface to be covered much larger. Nevertheless, the results are extremely gratifying, and, notwithstanding the great difficulties, the nightly illumination is as popular and attractive a feature as at other previous expositions. One of these difficulties arises from the fact that the buildings are arranged in such a manner that, contrary to the precedents set by previous expositions, there is no one spot where the observer can get a comprehensive view of the greater part of the decorative lighting. Unlike Chicago, Omaha or Buffalo, the visitor must get impressions of the illumination at St. Louis somewhat "on the installment plan. A "Court of Honor," which will afford one comprehensive view surpassing all others, is not to be had at St. Louis. There are, however, innumerable places where various new and charming vistas will be opened up if one hunts for them.

The nearest approach to the Court of Honor of previous expositions is in the view obtained when approaching the Cascades and Festival Hall from the main entrance, crossing the Plaza of St. Louis; but even there foliage and great distances somewhat dwarf the effect until the grand basin in front of the Cascades and Terrace of States is reached. Here the view is as shown in Fig. 1.

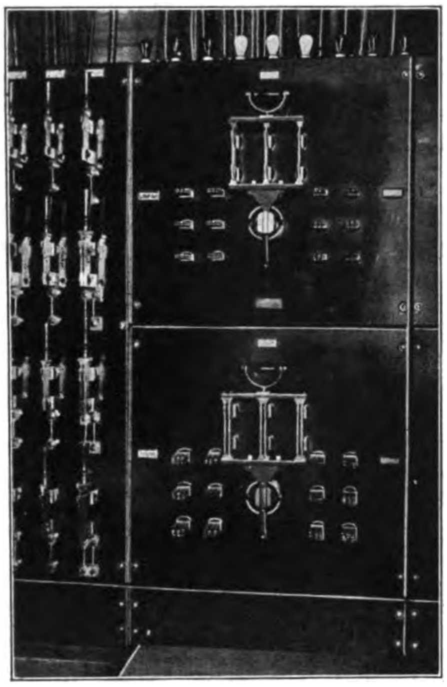

FIG. 2.—TRIPLE-THROW SWITCHES.

Festival Hall, the dome of which forms the central feature of this view, is the most intensely lighted of the exposition buildings, as it is the center and climax of all the lighting. Out of the front of Festival Hall comes the water of the Cascades, which flows in a constantly widening stream from terrace to terrace until the lagoon is reached. Green incandescent lights are placed beneath the water in rows under each terrace. When the exposition opened the lighting of the waterfall was decidedly poor and added little to the general effect. Since the opening, the addition of a searchlight on the Palace of Electricity, with its beams thrown on the water as it emerges at the top of the Cascades, has improved matters somewhat.

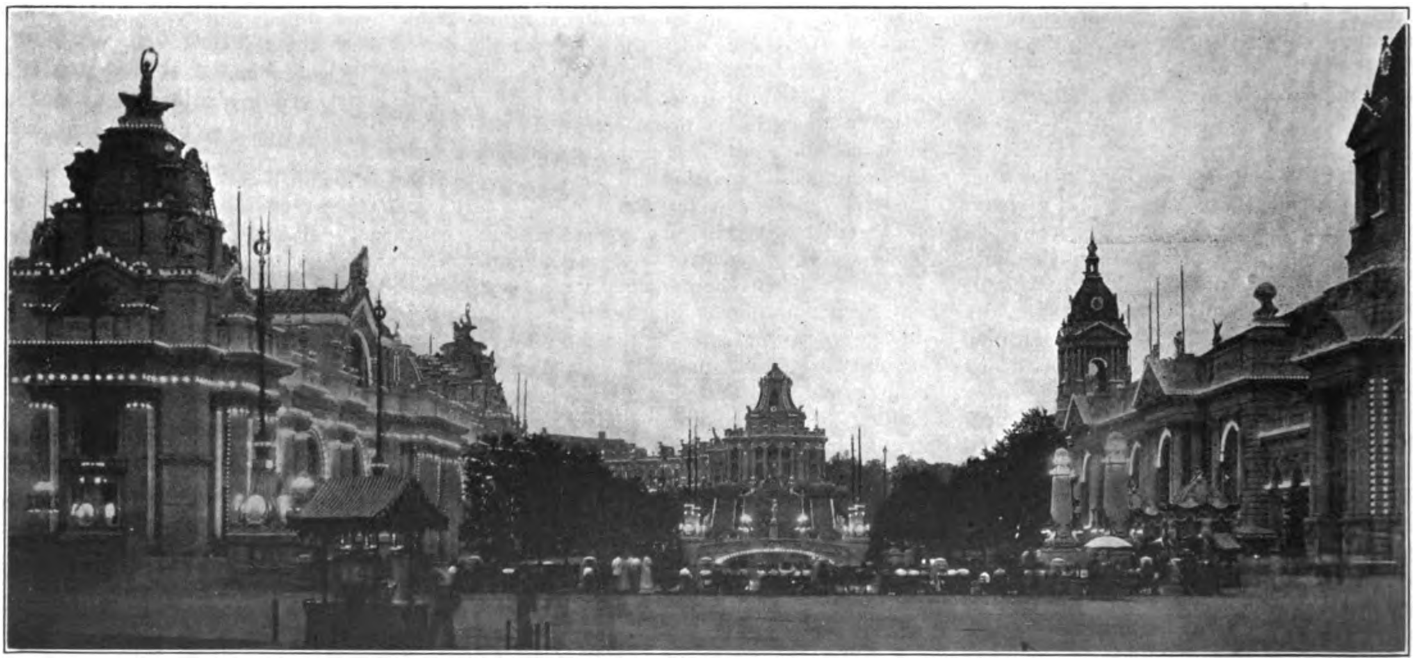

FIG. 4.—TWILIGHT VIEW FROM THE PLAZA OF ST. ANTHONY.

On either side of Festival Hall, Fig. 1, are the Colonnades, which are also plentifully supplied with light. Much of the lighting here is by concealed lamps placed so as to throw light on the columns from behind them and so illuminate the columns without revealing the source of light. The same principle is employed on some of the other buildings rather more effectively.

Festival Hall, the Colonnades and the two pavilions on each end are illuminated by three separate sets of incandescent lights. Each set is of a different color, emerald, ruby and clear bulbs being used. The effect produced by the sudden change in color of the great picture must be seen to be fully appreciated. In wiring the three sets of lamps to permit of their being operated independently, a four-wire system was used, one of the four wires being a common return for the three circuits.

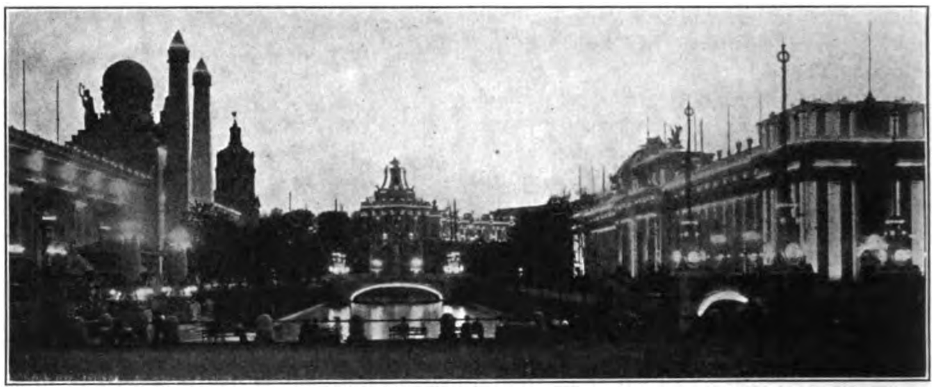

FIG. 5.—TWILIGHT VIEW FROM THE PLAZA OF ORLEANS.

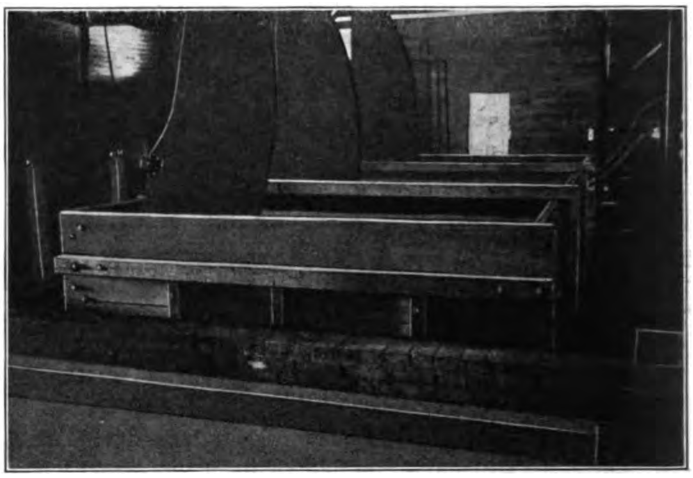

FIG. 3.—WATER RHEOSTAT.

Switchboards for operating the colored lamps are installed under the spillways of both the east and west Cascades, and in order that the two operators may work in harmony a set of signals is used between the two boards. Swivel switches, of the three-pole, three-throw type are employed. Each of the three required is rated at 400 to 500 amperes and 250 volts. Two of these are installed on the switchboard under the east spillway, Fig. 2. Each switch controls certain sections of the main picture.

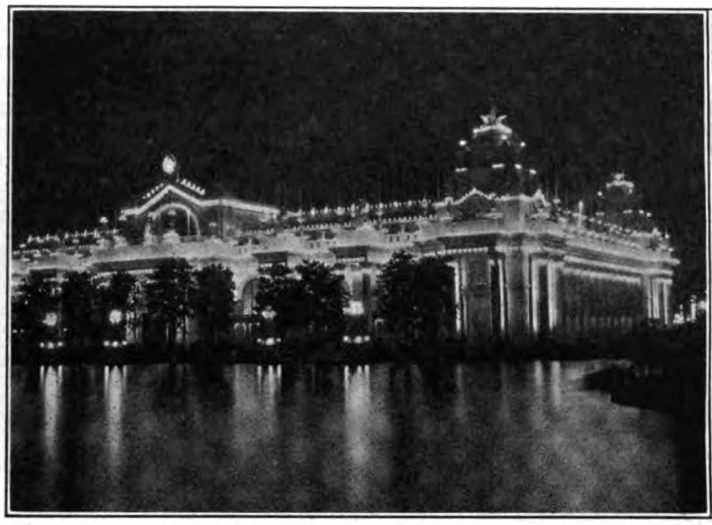

FIG. 6.—PALACE OF ELECTRICITY.

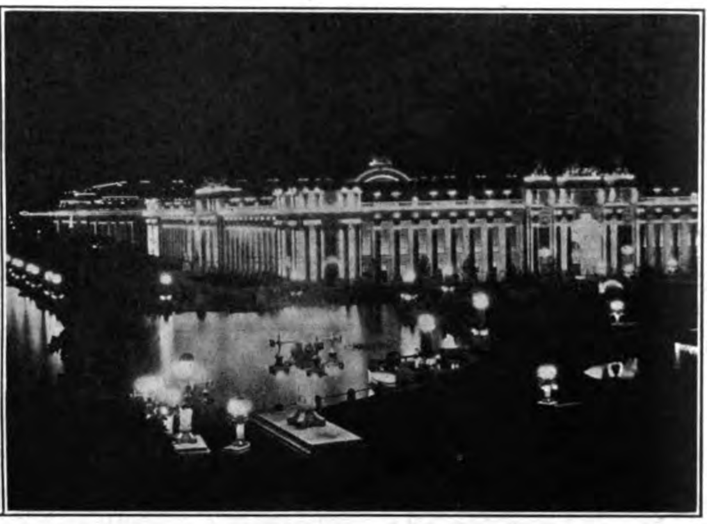

FIG. 7.—PALACE OF EDUCATION.

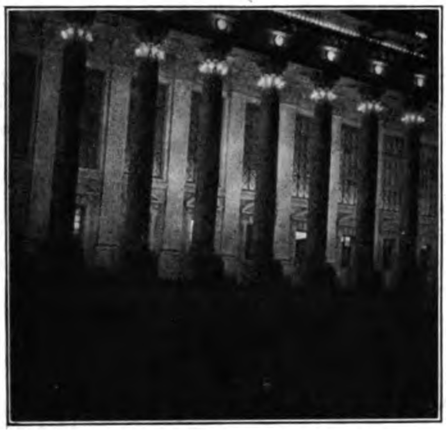

FIG. 8.

When the handles of the switches are thrown up, the clear lamps are lighted; when swung to the left, current is thrown on the emerald lamps; and when swung to the right, the ruby lamps are placed in circuit. At the present time it is customary to alternate the two colored systems with the clear bulbs, these latter being allowed to burn fifteen minues, and the colored lights being limited to five minutes.

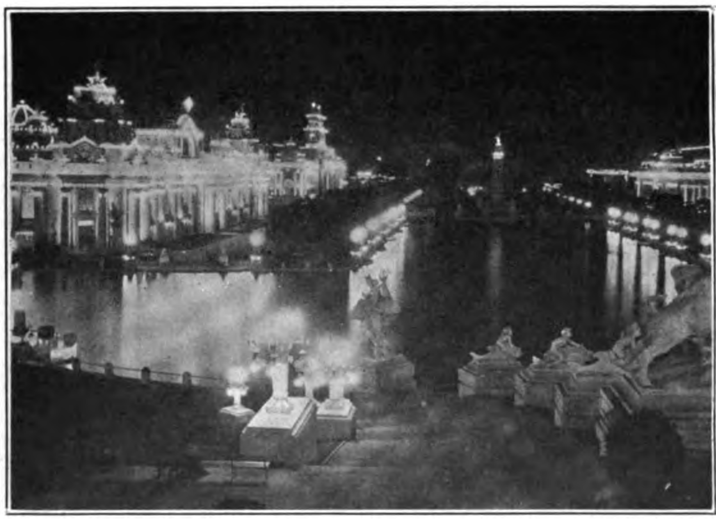

FIG. 10.—ELECTRICITY PALACE FROM THE CASCADES.

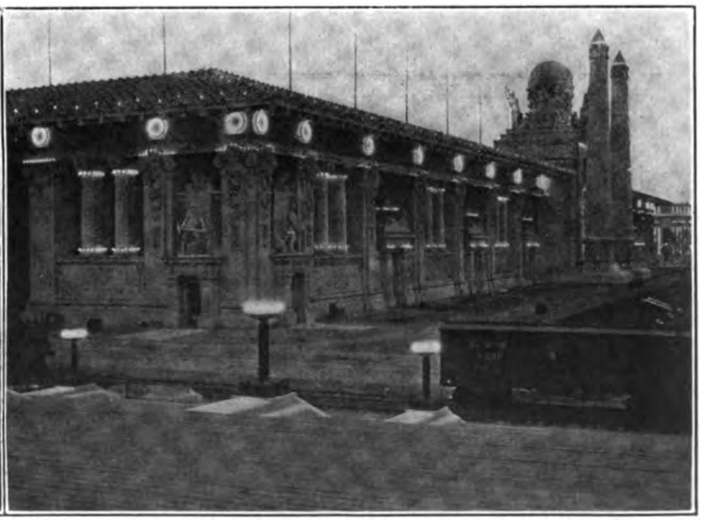

FIG. 11.—TWILIGHT VIEW OF PALACE OF MINES AND METALLURGY.

Resistances are placed in the circuit so that the separate systems of light may be gradually brought up to full candle-power. Water rheostats are placed under the west Cascade. These consist of large wooden tanks filled with water, as shown in Fig. 3, one of the electrodes being placed permanently in the liquid. The movable electrode consists of a flat piece of cast iron of peculiar shape and pivoted at one end; the other may be lowered into the water by means of a windlass, this windlass operating the three electrodes of the three tanks simultaneously, as in the case of the big water rheostat at the Pan-American Exposition.

At either end of the Colonnades are the Pavilions. A view looking from the Plaza of St. Anthony between the Palaces of Machinery and Electricity toward the west Pavilion is shown in Fig. 4. Fig. 5 is a view from the Plaza of Orleans, looking between the Palaces of Mines and Education toward the east Pavilion. These two latter views were taken at twilight, which is thought by many to be the most pleasing time to view the illumination, as at that time the details of the architecture are visible with their beauty enhanced by the decoration afforded by the incandescent lamps.

Of all the principal buildings the one most profusely decorated with lights is the Palace of Electricity, Fig. 6, on which sufficient lights have been placed to bring out more of the architectural details than on any other building in the exposition.

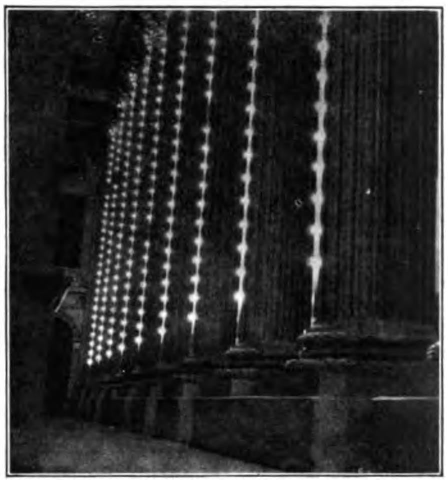

FIG. 9.

Another style of lighting is that shown in Fig. 7, which is a view of the Palace of

Education from the neighborhood of Festival Hall, looking down on the Grand Basin and showing some of the post lighting near the Cascades in the foreground. While it will be noticed that the number of exposed lights on this building is not large, the building is apparently all aglow.

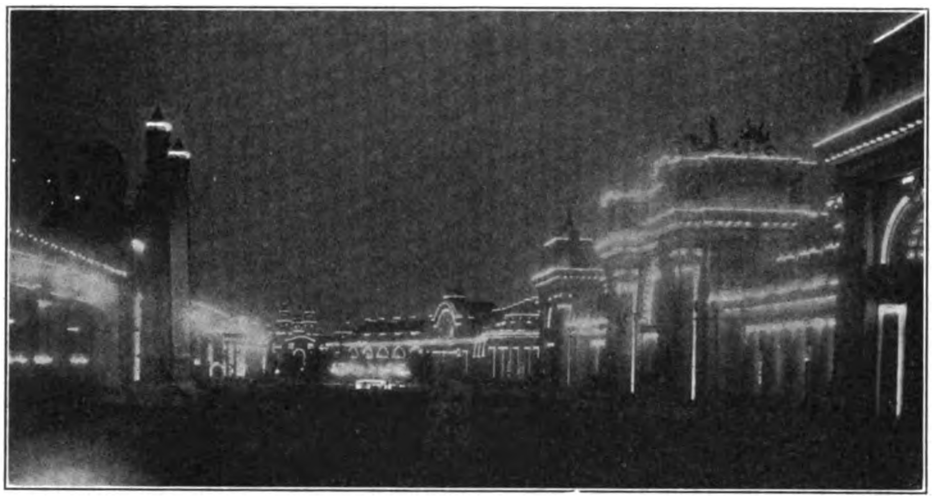

FIG. 12.—VIEW LOOKING WEST FROM GOVERNMENT BUILDING.

This effect is secured on this and a number of other buildings by the use of rows of lamps hidden behind the columns and casting their lights against the white sides of the building. A nearer view of the side of a building so lighted is shown in Fig. 8. How the effect is produced is shown in Fig. 9, which is a view taken behind the columns. Another grand view from the Cascades is that looking down on the Palace of Electricity, Fig. 10.

The Palace of Mines and Metallurgy has a style of architecture distinctly different from the other large exposition buildings. Being one of the less prominent, it was not wise or feasible to embellish it as lavishly as some of the other buildings, but the simple lighting decoration shown in the twilight view, illustrated in Fig. 11, is not without admirers. The Palace of Machinery, shown in Fig. 4, is also a building that has given pleasing effects with very simple treatment and a comparatively small number of lamps. In this case there is no attempt to bring out detail of architecture, but the building has been decorated with plain rows of lights. Fig. 12 is a view looking west from the Government Building, with the Palace of Liberal Arts on the right, the Palace of Mines and Metallurgy on the left, and the Palace of Manufactures in the background. This is a characteristic view, and a number of such are available along the long curved which are remarkably effective, and others court or avenue facing which all the larger exposition buildings are located.

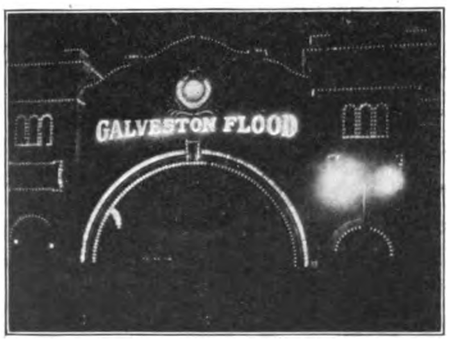

FIG. 13.—GALVESTON FLOOD.

The exposition offers an excellent opportunity for the electrical engineer to study the effects of different designs of electric signs. The "Pike" is lined with electric signs from one end to the other, some of are striking examples of "how not to do it." In general, it can be said that the electric signs which are most successful are those which are most easily read and which stand out clean-cut and distinct. One good example is that in front of the "Galveston Flood," Fig. 13; another is "Under and Over the Sea," Fg. 14. Both of these signs employ lamps of low candle-power and a form of lettering which does not blur one part of a letter into another when the letter is seen from a distance at night. In contrast to these signs are the ones employed at the Intramural stations, Fig. 15. Sixteen candle-power lamps are used in these signs and the letters are of such a design that a person standing some distance away, or not directly in front of the sign, cannot read the sign at all, but sees only a blur of light. Another form of electric sign is that at the terminal station of the Wabash Railroad at the Exposition Grounds, Fig. 16; this can be read at a great distance, although the intensity of the light from the sign is very low, the lamps themselves being hidden. The light comes through perforations in the face of the sign. Electric light is very effectively used for advertisement and decoration on the attraction called "New York to the North Pole," Fig. 17. This building is made to stand out at night by incandescent lamps scattered over its surface and also has a very effective electric sign. The attempt to outline the ship's rigging will hardly be called a success, however, until it is carried out further so as to outline more of the rigging.

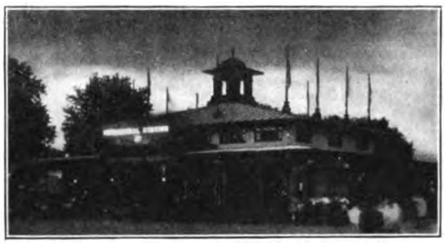

FIG. 15.—INTRAMURAL STATION.

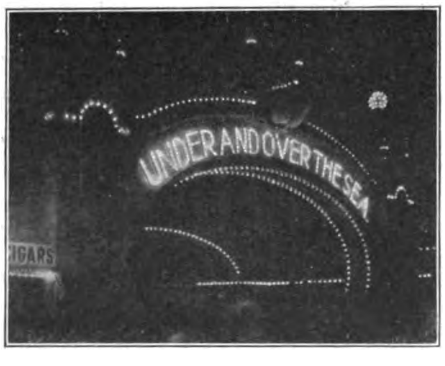

FIG. 14.—UNDER AND OVER THE SEA.

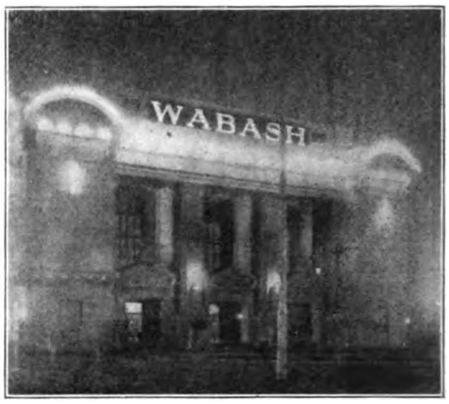

FIG. 16.—WABASH TERMINAL.

The decorative lights of the exposition are 8 candle-power, 110-volt lamps, run on a four-wire system of distribution. The circuits are supplied from transformers located at sub-stations in each of the principal buildings. These transformers are supplied with 6600-volt, three-phase, 60-cycle alternating current from the Exposition power plant in the Palace of Machinery. A separate feeder is run to each sub-station and the decorative lighting is kept independent of the other load at the switchboard. Ordinarily the lighting load is carried by the 3500-kw. Allis-Chalmers-Bullock unit. The lights are turned on at twilight, being brought up to brilliance slowly by gradually exciting the fields of the generator. The load takes about the full capacity of this generator. The bringing of the lights up to full brilliancy gradually is not only desirable from an engineering standpoint, because it avoids throwing a large load on the generator suddenly, but is very impressive from a spectacular standpoint, the turning on of the decorative lights being one of the great daily events of the exposition that is watched for by thousands.

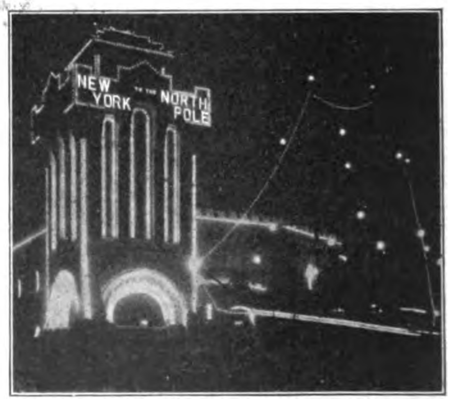

FIG. 17.—NEW YORK TO THE NORTH POLE.

LARGEST STEAM-DRIVEN POWER STATION IN THE WORLD

STEAM PLANT OF THE NEW YORK INTERBOROUGH RAPID TRANSIT COMPANY.

With an insert.

An epoch will be made in the development of the central power plant for the generation and distribution of electrical energy in the approaching completion of the Fifty-ninth Street power plant of the Interborough Rapid Transit Company in New York City, for operating the trains of the new Rapid Transit Subway. Some conception of the magnitude of this plant may be gained when it is considered that this will be the sole source of power supply for the operation of about 800 trains under close headway on 13 miles of three and four-track line. Added interest is aroused by the fact that steam turbines will be used in addition to large reciprocating engines and that these large engines of 8000 horse-power capacity each will be equipped with poppet valves for use with superheated steam.

The building has a frontage on Eleventh Avenue of 200 feet and will have a depth along Fifty-eight and Fifty-ninth Streets of about 700 feet, ending with a brick wall of a semi-temporary nature which will be removed in the event of the building being extended. It is of skeleton steel construction; the side walls, of brick, terra cotta and granite, are self-supporting and are built independent of the steel work.

In arrangement the building does not differ materially from that of the larger power plants, with which the reader is doubtless familiar and which have come to be accepted as the most approved design. It is separated transversely into practically two distinct buildings, the boiler house on the south side and the engine house on the north, by a heavy brick division wall which extends from the basement to the roof. The engine room is divided into three bays, the center or main bay being the operating room and contains the prime-movers; this bay is balanced by the steam pipe area on the south and galleries on the north. In the steam pipe area are placed all boiler feed pumps, dry vacuum pumps, circulating water pumps, main steam pipes with their manifolds, and the equalizing line; the exhaust pipe to the atmosphere also passes through this part of the building to the roof. Commencing at the floor on which the main steam pipes enter from the boiler house, this "area" is separated from the main operating room by a brick enclosure wall which will prevent steam entering the operating room in the event of a steam pipe failing. This wall extends to the second floor above the one on which it starts. The galleries on the north side of the engine house are devoted entirely to electrical equipment.

The engine house is covered by a roof with two pitches, that portion of the roof having the steeper pitch being covered with skylight, the other with slab construction.

The boiler house is laid out with an exceptional degree of economy of floor space, only one floor being devoted to boilers. These extend in two unbroken rows the entire length of the building, this being made possible by the novel scheme of supporting the chimney stacks from a platform located about on a level with the roof. Above the boiler floor is the economizer floor, which is devoted to smoke flues and economizers with a coal distributing conveyor system. The coal bunkers are so located that the hoppers open directly over this floor. The boiler house is covered with a main roof with a monitor. Longitudinally the building has been divided into sections or bays, and with the exception of the turbine bay, each is an exact duplicate of the other. Each will consist of a generating set, the necessary boilers to supply the steam, its boiler feed pumps, circulating water pumps and dry vacuum pumps; the only features making them at all interdependent are the chimney stacks and the discharge from the hot wells, one of each being provided for two sections or bays.

The interior of the operating room will be furnished around the side walls with a cream-colored enamel brick wainscotting, carried to a point about 7 feet above the floor, and will have a molded cap and base. Above this wainscott all the interior walls that are exposed to view will be finished with a face brick of a light buff color.

The steel work is of an extremely massive design, so much so that it may be classed in bridge work. The floors generally consist of I-beams and plate girders, the girders being as a rule placed 3 inches below the finished floor level and the connecting beams from 1½ to 2 inches below that, depending on the thickness of the girder flange, thus avoiding the necessity of coping. Where the floor beams connect to girders, they rest on a specially designed seat which is riveted to the web of the girder. The beams are riveted to this seat, and in addition have a side angle or "knee" riveted to the web, which rivets to the web of the girder. Where beams or girders connect to the faces of columns a similar seat is used, but instead of using a side angle a clip angle is provided, which rivets to the top flange of the beam or girder and to the face of the column. These seats were designed to carry a load greater than one-half the maximum carrying capacity of the beams for which they were intended, and sufficient rivets in single shear were provided to take care of that load.

The columns, with the exception of the wall columns and those carrying the stack, which are of plates and angles, are of plates and channels, the channels being 12 inches deep and the plates 18 inches wide. The channels and plates vary in section, depending on the load that the column carries. The wall columns up to the third tier are of the box type of plate and angle construction, and are 18 inches x 24 inches outside dimensions; above the third tier they are of 12-in. channels and 16-in. plates

As the main operating room in the engine house is 78 feet wide between the center lines of the columns, there is a stretch of wall of that distance across the ends, which must be protected against wind pressure. This has been done by using two plate girder columns 42 inches deep, with flanges 13 inches wide, anchored to foundations at the bottom and to a plate girder, with its web horizontal, at the roof line. At two points between, where floors occur, additional provision is made by means of latticed girders placed with the webs horizontal and connected to the floor system and these columns.

The method of supporting the crane girders deserves particular mention as it is simple and extremely effective. In order to provide the necessary clearances for the crane, and to avoid the excessive bending moment on the columns attendant thereto, the idea of using cantilevers to support the girders was developed very successfully. These cantilevers are of angles latticed, with a web plate and reinforcing plate extending from the supporting column to the crane girder. They are riveted directly onto the face of the columns, one on each side of each column, thereby bringing the load from the crane directly concentric on the column. The small uplift from the cantilever is provided against by their outer ends being connected to the columns in the next longitudinal row. The reinforcing plate was made necessary by the excessive shear that was brought on the cantilever where they connected to the supporting columns.

The roof trusses over the engine house are supported by the crane supporting columns, which are carried up to the proper height for that purpose, and the trusses span 78 feet from center line to center line of the columns. Lattice purlins span from truss to truss and support the I-beam, rafters, and the skylight bars.

The roof over the boiler house consists of a main roof with a monitor. The main roof trusses are supported upon columns which are independent of the building columns, and the monitor trusses come directly over the main roof trusses.

The coal bunkers are of heavy I-beam and plate-girder construction, the bottom being formed of three plate girders, one horizontal and two inclined at an angle of 45 degrees, the beams being riveted to the top flange. The end bulkheads are of 15-in. I-beams placed vertical, the bottoms being connected to the horizontal and inclined girders; the tops are riveted to heavy plate girders 42 inches deep which are placed with their webs in a horizontal position, thus providing against the thrust due to the immense body of coal in the bunkers; along each side of the bunkers and at such a level that the girders just described are riveted thereto is a girder of T section, the top consisting of a plate 24 inches wide with an angle at each edge, the web, or what would be considered the stem of the T, being formed of a plate 30 inches wide and four angles. The arrangement of these girders forms a rectangle in such a manner as to cause the pressure on the four sides to neutralize.

The steel work supporting the chimney stack is very massive and consists of a platform of 24-in. I-beams, directly on which rests the brickwork of the stack; these are supported by a system of plate girders 8 ft. deep. The columns supporting this great weight are of box section of plates and angles and are about 16 x 20 inches.

The foundations offered quite a serious problem, owing to the irregular formation of the bed rock. At the northeast corner of the site, 12 ft. of the rock had to be blasted away in order to get down to the level required, while at the west end rock was not found until 35 ft. below the surface. Cast-iron bases were used to distribute the weight carried by the columns over an area large enough to bring the unit pressure within the limit prescribed by the building laws, and where bed rock was found close up to the bottoms of the bases they were set with a pad of concrete 12 inches thick for leveling purposes.

Where piers were required they were built of concrete of such size as to be perfectly stable and were carried down to bed rock; they were capped with a granite base stone on which the cast-iron base was set. The wall footings are of concrete and are carried down to rock, waterproofing being provided on the external surface carried up to the level of the sidewalks.

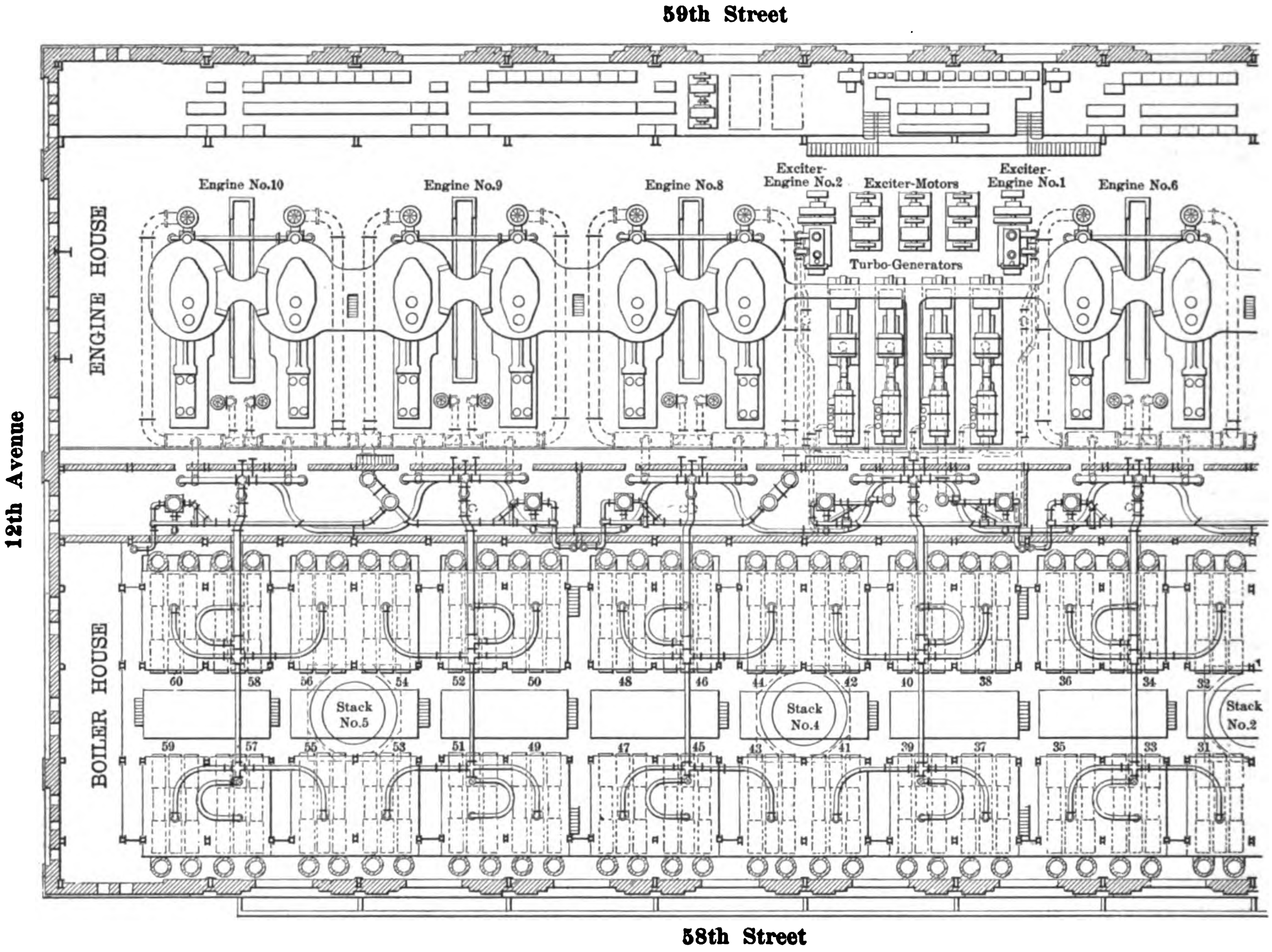

FIG. 1.—PLAN VIEW OF WEST HALF OF INTERBOROUGH RAPID TRANSIT POWER HOUSE.

In order to meet the extreme requirements, the floors were made very strong and are of concrete arches, reinforced with expanded metals, sprung between the floor beams from the bottom flanges, when the beams are of the same depth. When there is a difference in the depth of the beams, or an arch is turned from a beam to a girder, a shelf angle is riveted to the deeper member level with the bottom flange of the shallower one. The tops of these arches are about level with the tops of the beams and their intrados have a rise of about 1½ inches per foot of span; over this is a filling of cinder concrete to within about 2 inches of the finished floor. This 2-inch space is taken up with a granolithic finish which brings the floor up to the proper level. The floor construction is to stand test loads as follows: 200 pounds per square foot on all flat portions of the roof, 500 pounds per square foot in the engine house, and 300 pounds per square foot in the boiler house.

The main boiler house floor is of the masonry arch construction just described, and the uniform load was taken at 300 pounds per square foot. In front of the boilers, where the wear will be greatest, cast-iron checkered plates are located. These plates are three feet wide and extend the full width of a battery, or 30 feet. Directly behind each battery of the row on the north side are gratings of 2½ x ⅜-in. flat steel bars on edge and spaced 1¼ inches from center to center.

In the engine house the floor that corresponds to the level of the main boiler floor just described is on the north side and is devoted to electrical apparatus, as are all the floors on that side of the building. They are of the construction described as to masonry arch work, but have in addition a second floor about 15 inches above the true floor, of slate slabs resting on brick partitions, which form compartments or ducts in which cables are laid. In the south side or pipe area there is a series of platforms at a height convenient to operate the pumps.

About 8 feet above the main boiler house floor is located the main operating floor of the engine room. It is from this floor that all the main engines, exciter engines and turbines will be operated. This is of regular construction and is designed for a uniform load of 500 pounds per square foot. Around each alternator special flooring is provided, so arranged as to be easily removed should occasion arise.

In the boiler house the floor at this level consists of a system of platforms which extend in front and between all boilers and in the rear of the north row of boilers against the division wall. The platforms are perforated cast-iron plates ⅞ inch thick supported on steel I-beams. They are located so that easy access is had from the main operating floor of the engine house through doors in the division wall. These platforms are at such a height with relation to the boilers as to make it convenient to do any work that may be necessary about the boiler tubes, and are a decided advantage over the common method of building a makeshift scaffold when such work is to be done.

The railings around the openings in the various floors and around the galleries, with the exception of the main switchboard galleries and the openings in the main operating floor, are to be of wrought-iron pipe supported by cast-iron stanchions. These stanchions are to be bolted directly to the steelwork, and where cast-iron plates are used for the floor they are fitted around the bases of the stanchions. The railings around the openings in the main operating floor will be of brass tubing in polished steel stanchions, while about the main switchboard galleries the railings are to be of wrought-iron scroll in panels between wrought-iron balusters, with a hand rail of galvanized-iron pipe.

In most boiler installations the tops of the boilers are left about as they happen to be when the workmen finish the setting, no effort being made to provide a convenient platform about the steam pipe connections for the use of workmen who may have occasion to go there. In this plant ample provision for the convenience of working about the tops of the boilers has been made by means of a platform of steel plates reinforced with stiffening angles, which is laid directly on top of the beams supporting the boilers. These platforms are connected with each other by a walkway at the rear of the boilers, extending the entire length of the building. The plates are removable, with a few exceptions, and a perfectly smooth surface is presented, all rivets being countersunk on the exposed side. In the steam pipe area in the engine house, at this level, is located the main steam pipe floor, which is of the concrete construction already described; here are located the steam manifolds, the equalizing line, the feed-water heaters, etc. Communication is had from this floor to the platforms over the boilers by means of doorways which open on to the walkways connected with the platforms.

The economizer floor is located next and is devoted to the smoke flues, economizers and a coal-distributing conveyor. In this floor and over the valves in the main steam header are located gratings of 2-in. x ⅜-in. wrought steel on edge, which may be removed to facilitate working around these valves.

The handling of a quantity of coal of such magnitude as will be necessary for the operation of this plant becomes quite a problem and the solution that is adopted has great interest. The conveyors used throughout, with one exception, are the Robins belt type; the one exception is a scraper conveyor on the economizer floor. The entire handling equipment was furnished and installed by the Robins Conveying Belt Company.

The coal will be received at the Fifty-eighth Street pier in barges and will be unloaded by a tower unloader of a capacity of 125 tons per hour. This unloader is equipped with crushing rollers and weighing machines. After the coal passes through the rolls and weighing machines it is deposited on a belt conveyor operating on the surface of the dock; this in turn dumps the coal on the first of a series of conveyors traveling in a tunnel under the sidewalk of Fifty-eighth Street; this tunnel is sufficiently large to accommodate a second system of conveyors should it be considered necessary. The last conveyor in the tunnel deposits the coal on the first of the elevating conveyors, which will operate in the westerly end of the building. They are inclined at an angle of 22½ degrees from the horizontal and run at a speed of about 375 feet per minute; they are 110 feet from the center line of the tail pulley to the center line of the head pulley. There will be four of these inclined conveying units in tandem; the last one of the series will deliver the coal to either of two parallel conveyors operating longitudinally of the building; these are located directly on the horizontal top chord of the main roof truss at equal distances each side of the center line of the coal bunkers and are equipped with movable unloaders which can be located to unload coal at any point into the bunkers. Each conveyor runs about 10 feet a minute faster than the preceding one, in order to surely clear all coal away. The capacity of these conveyors will be about 200 tons per hour.

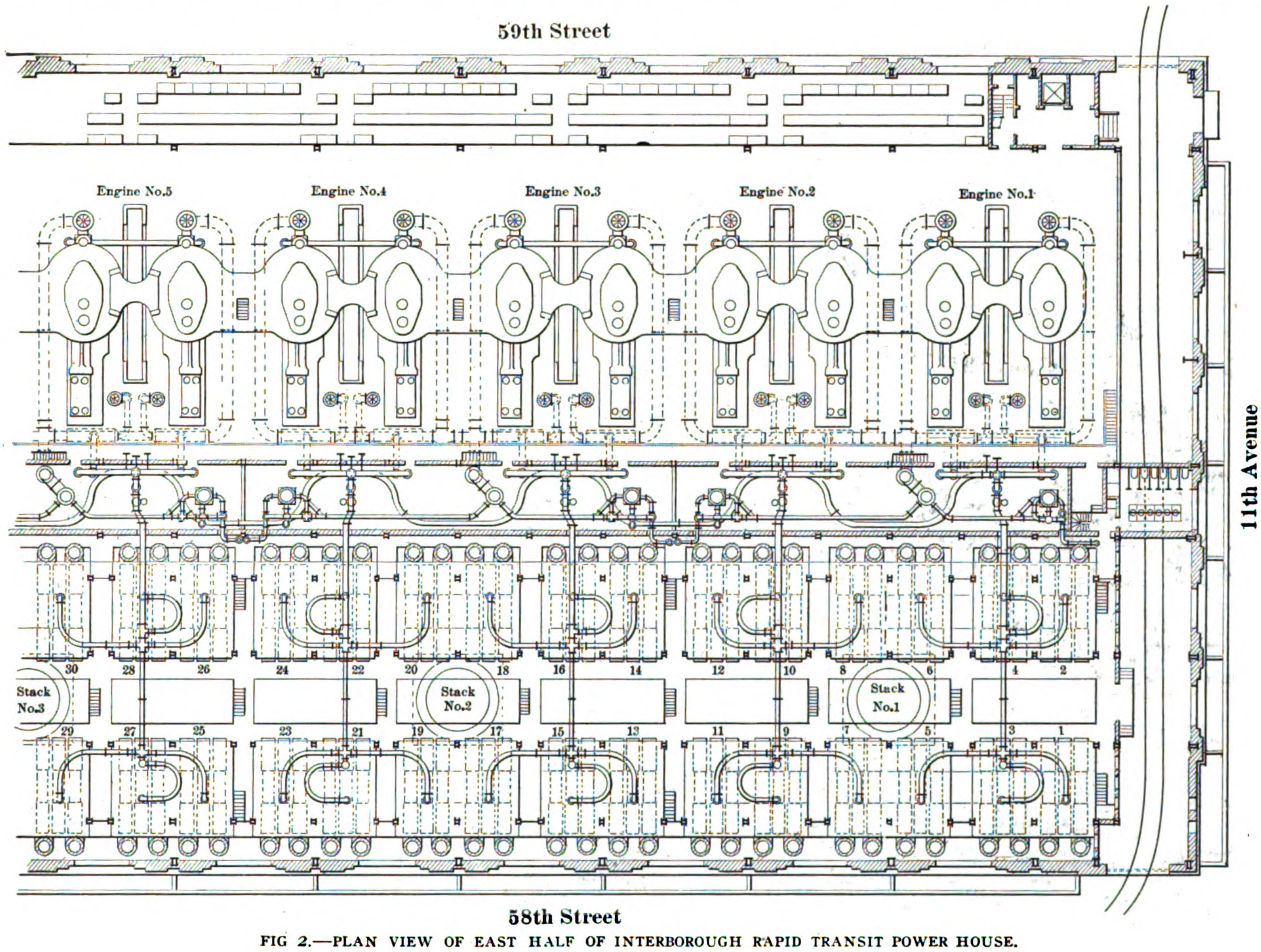

FIG 2.—PLAN VIEW OF EAST HALF OF INTERBOROUGH RAPID TRANSIT POWER HOUSE.

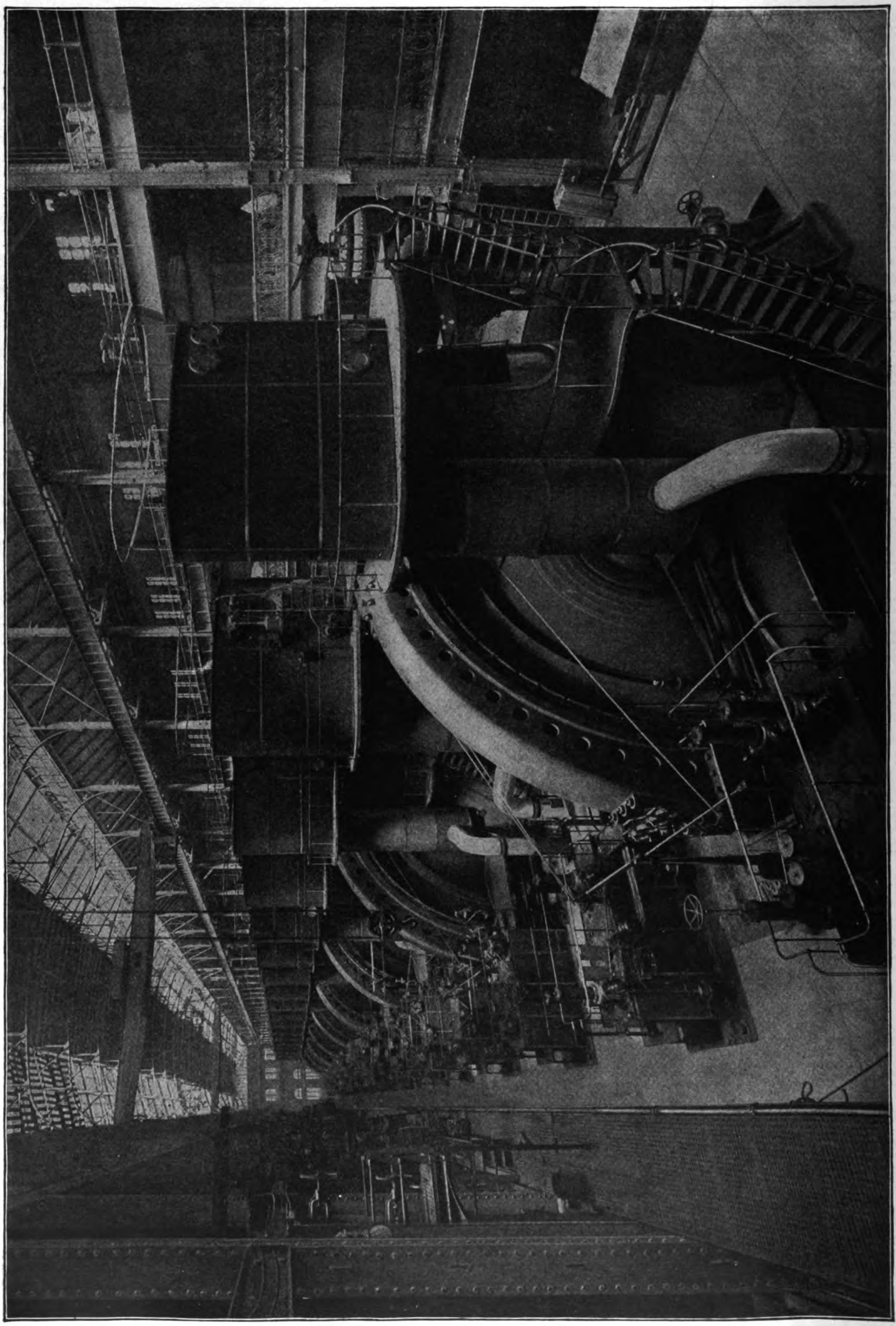

FIG. 3.—OPERATING ROOM OF NEW YORK INTERBOROUGH RAPID TRANSIT POWER HOUSE.

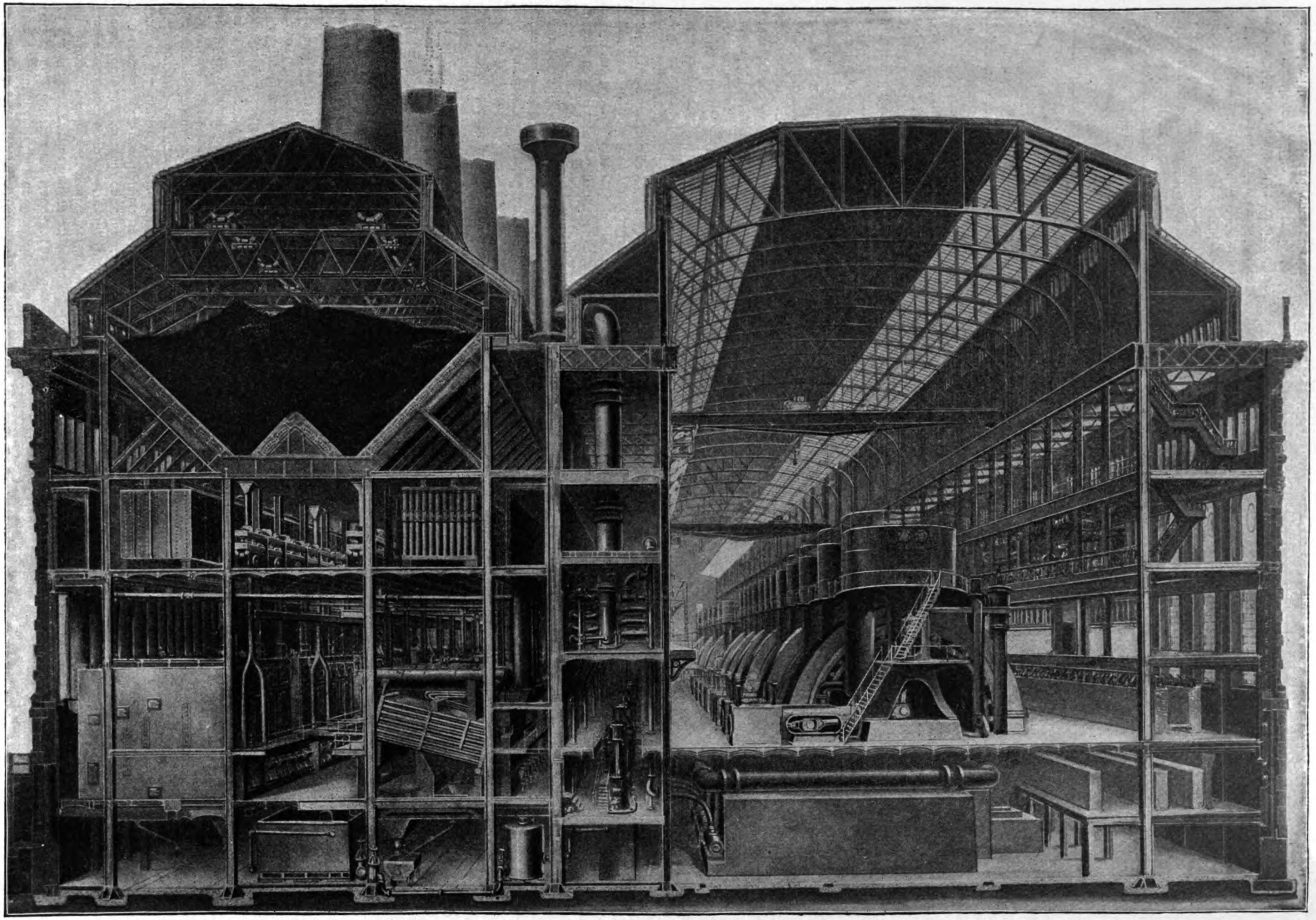

FIG. 4.—COMPLETE VIEW OF THE INTERIOR OF NEW YORK INTERBOROUGH RAPID TRANSIT POWER HOUSE.

The coal after leaving the conveyors is stored in bunkers about 61 feet wide and 80 feet long between the stacks. The sides of the bunkers are inclined at an angle of 45 degrees and bulkheads rise vertically 6 feet above the point where the inclined walls join the vertical ones. There are two rows of cast-iron hoppers in the bottoms of the bunkers located on the center lines about 17 feet apart symmetrical about the longitudinal center line of the bunkers, and 18 feet apart lengthwise of the building. The bottom of each bunker is hoppered at an angle of 45 degrees so as to completely clear itself of coal. The capacity of all the bunkers is estimated to be about 12,000 tons level full, or 16,000 tons if heaped. The bottom, sides and bulkheads are constructed of concrete arches reinforced with expanded metal. The whole surface that is exposed to contact with the coal is faced with a Portland cement body 3 inches thick and a granolithic finish 1 inch thick.

From the bunkers the coal will be delivered through the cast-iron hoppers located in the bottoms into cast-iron pipe chutes, each provided with a gate where it joins the hopper; these chutes deliver the coal into other hoppers located directly on the economizer floor, or into a scraper conveyor operating directly over the said hoppers, which is provided in order to be able to feed coal from any bunker in the building to any set of boilers. As it was necessary to be able to deliver the coal from the chutes into either the conveyor or the hopper, a very ingenious device was made use of; it consists of a bonnet-like affair of cast iron provided with two cut-offs, one opening into the hopper and the other on to the conveyor. From each of these hoppers, which rests on the floor, two more chutes branch off, each leading to the center of the battery of boilers on either side of each hopper, where it again separates into two more chutes which deliver the coal either into the hopper of the stokers or on the cast-iron plate in the boiler room floor directly in front of the firing doors. The entire installation is noticeable for the elimination of manual labor in handling the coal from the coal barges to the furnace.

The ashes after leaving the grate fall into hoppers which are of steel plate reinforced with stiffening angles; the outlets of these hoppers are controlled by gates opened by a lever, which will be operated by hand. Directly under the hoppers an industrial railway is laid for the operation of self-dumping ash cars of 2 tons capacity. These cars are drawn by enclosed electric locomotives. After leaving the basement the cars full of ashes are carried over a hopper and dumped. This hopper feeds to either one of two conveyors, one of which delivers the ashes direct to the loading tower that loads them on scows and the other delivers the ashes to a storage bunker of the Berquist suspension bunker type. This bunker is for storing ashes pending their removal, and has two spouts opening on a belt conveyor which delivers to the loading tower before mentioned. The bunker is to be enclosed with a steel and corrugated-iron

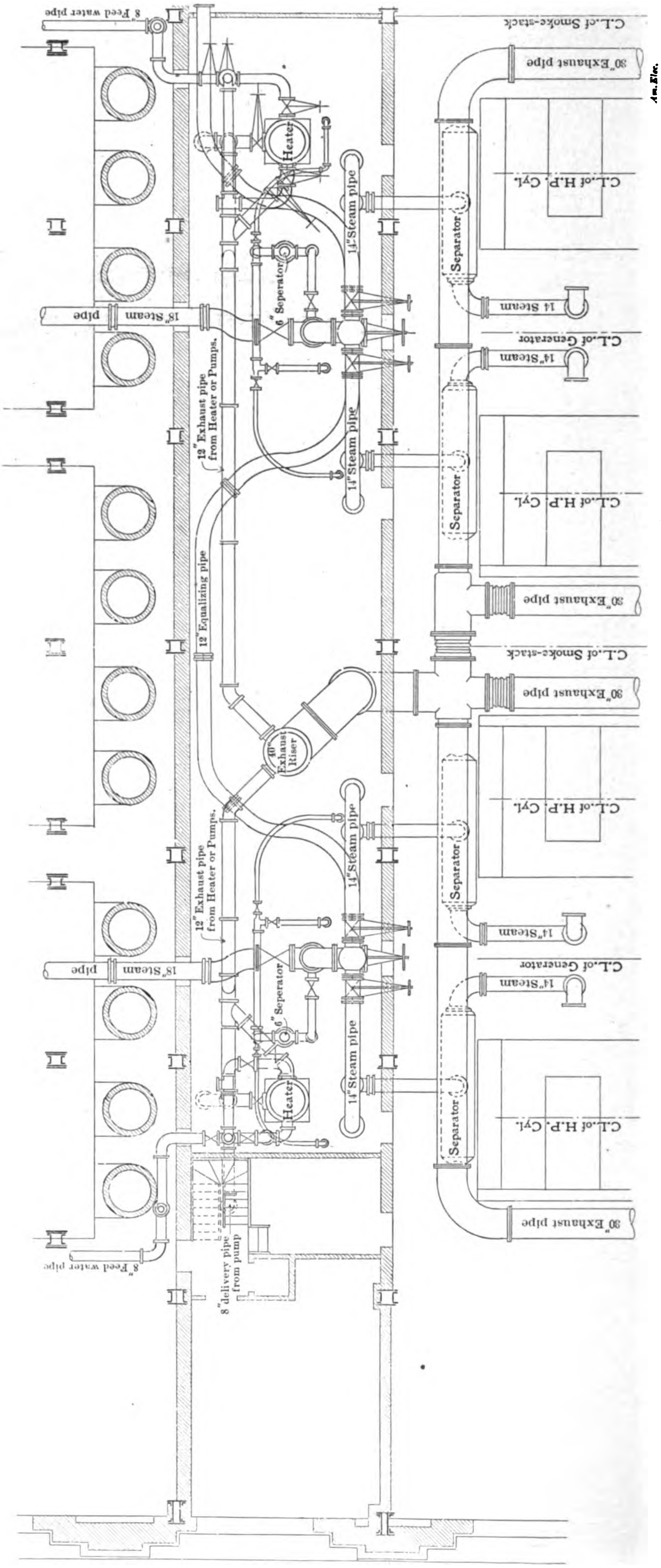

FIG. 5.—DETAIL VIEW OF PIPING TO MAIN ENGINES.

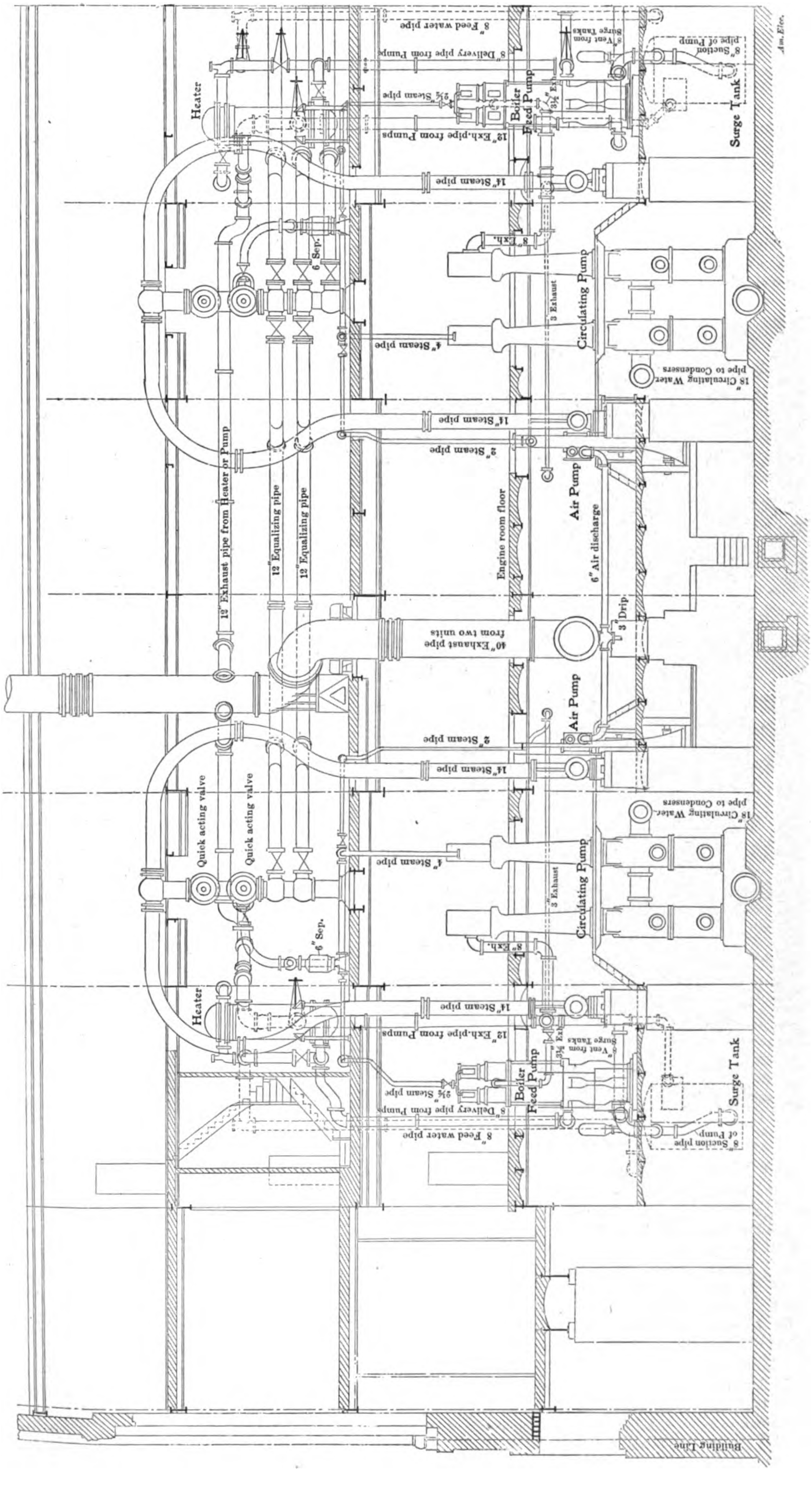
Heater
Surge Tank
Boiler Feed Pump
8" Feed water pipe
8" Delivery pipe from Pump
2½" Steam pipe
12" Exh. pipe from Pumps
14" Steam pipe
8" Exh.
3½" Exh.
8" Vent from Surge Tanks
8" Suction pipe of Pump
Circulating Pump
3" Exhaust
4" Steam pipe
18" Circulating Water pipe to Condensers
2" Steam pipe
Air Pump
6" Air discharge
Engine room floor
12" Exhaust pipe from Heater or Pump
12" Equalizing pipe
6" Sep.
40" Exhaust pipe from two units
3" Drip
Quick acting valve
Building Line
Am. Elec.

FIG. 6.—DETAIL VIEW OF MAIN AND AUXILIARY STEAM AND EXHAUST PIPING.

structure above the girders that support it, and is lined on the inside with concrete and expanded metal to protect the steel of which it is made from the ashes. It might be interesting to add that alternating-current motors will be used throughout the entire coal and ash-handling systems.

The steam generating system will consist of 72 boilers and accessories; there will be 144 circular uptakes leading to 24 horizontal flues which, in turn, lead to six chimney stacks. Four units of Green economizers will be installed at first. If it is concluded to equip the entire plant with economizers there will be 24 of these, one at each horizontal flue. There will be nine Worthington boiler feed pumps 12 in. and 17 in. x 8½ in. by 15 in., and ten closed feed-water heaters; six boiler blow-off tanks, and eight storage tanks. In addition to the natural draft from the stacks, provision has been made for forced draft by means of fans. This equipment consists of two engine-driven fans, 7 feet in diameter, for each section of six boilers, the air being delivered beneath the grates.

The boilers used are the Babcock & Wilcox water tube type, of 600 horsepower rating each, having 6,000 square feet of heating surface, 100 square feet of grate surface, and are arranged in batteries of two boilers each. Each boiler consists of three drums, 23 feet 3 inches long and 42 inches in diameter; 294 4-inch tubes, 18 feet long, and is built for 200 pounds pressure. One of the features of these boilers is that of making headers to take 14 layers of tubes, thus obtaining a larger heating surface without having to extend the boilers transversely, or lengthwise of the boiler house; by such careful attention to details the necessity of having two floors of boilers was obviated. The boilers are to have for the main part hand-fired grates, though the settings have been designed to accommodate, with minor changes, any one of four different makes of automatic stokers. Of the first installation of boilers, 36 will be fitted with hand-fired grates and 16 with stokers; 10 will be equipped with superheating coils, 6 to have the B. & W. superheater and 4 to have the Foster superheater. The Foster superheater consists chiefly of parallel rows of straight elements joined at their ends to return headers and manifolds. The straight elements are fitted with concentric cores which confine the steam to thin annular spaces with smooth surfaces through which the steam is passed at high velocity. The exterior of the elements is provided throughout with a series of projecting flanges or gills for increasing the surface in contact with the hot gases and for giving strength. Moreover a great mass of metal is provided which serves as a storage for heat and tends to secure a uniform temperature of steam despite any fluctuation in the heating gases. These boilers are piped up in batteries of six, each battery to supply one engine with steam; two such batteries will be connected to each chimney stack. The boilers equipped with superheaters will be principally used to supply the turbines and are located in the turbine bay.

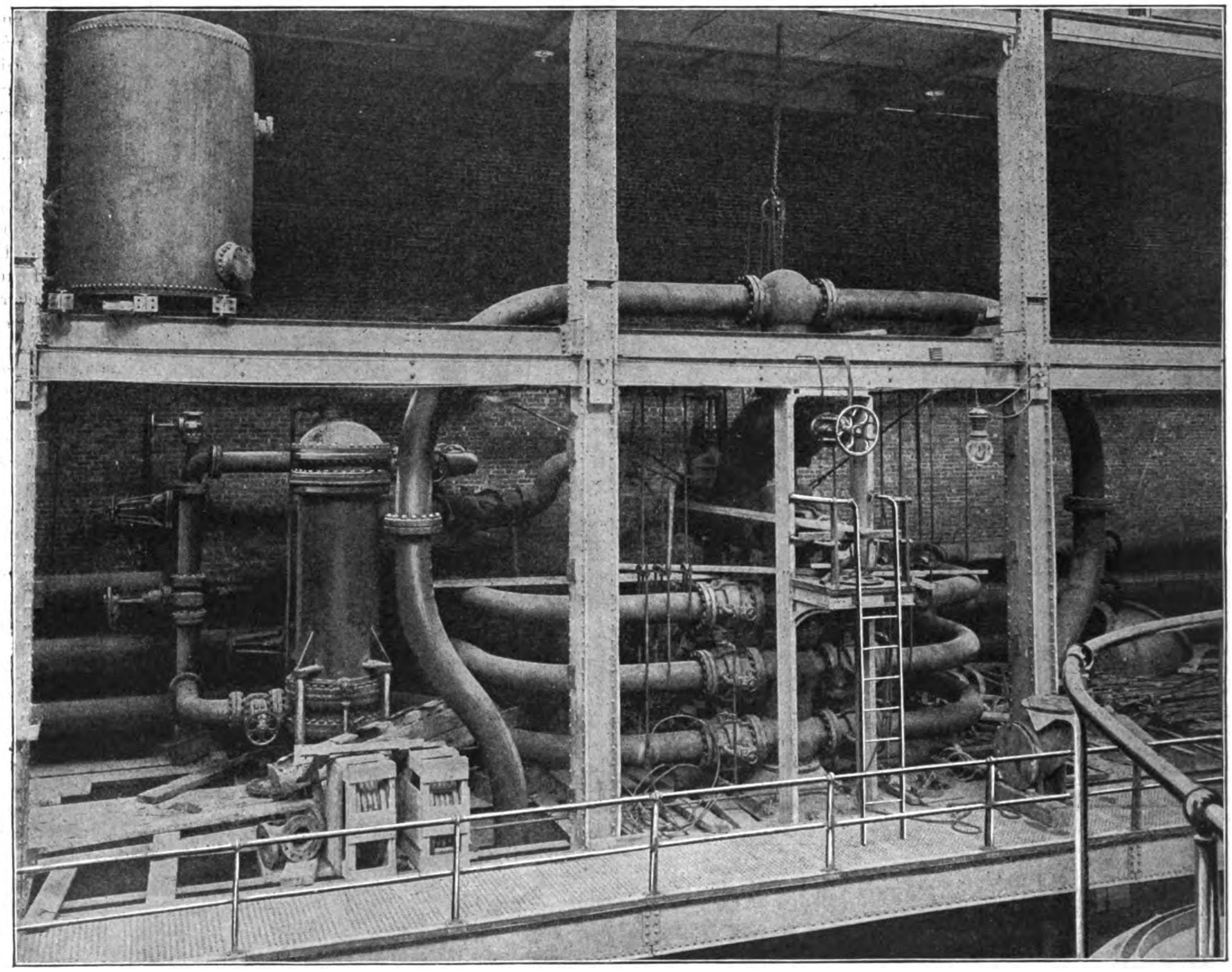

FIG. 7.—PORTION OF MAIN STEAM PIPING IN PIPE AREA.

The feed water is delivered into the boilers from 8-in. feed mains located directly under, and supported from, the main boiler room floor through 3-in. extra heavy seamless brass pipe, which supplies a 2½-in. branch pipe of the same material leading into the boiler drums. Each of these pipes is supplied with a 3-in. gate valve connected directly to the outlet of the main, a 3-in. special straightway disc valve, a 3-in. special check valve, and a 3-in. special angle valve.

The blow-off pipes, of which there are two to each boiler mud drum, are of 2½-in. brass extra strong pipe fitted with a 2½-in. extra strong blow-off valve and an asbestos packed plug cock. These blow-off pipes discharge into a 4-in. header that leads to the blow-off tanks, which are connected to the hot-well discharge trench, and have also an 8-in. vent pipe discharging into the 12-in. exhaust pipe from the pumps to the heaters.

At the rear of each boiler, two flues or uptakes 3½ feet in diameter connect the boiler to the horizontal flue or smoke duct 6 feet 4 inches x 13 feet 2 inches, located on the economizer floor; this smoke duct forms a header for the uptakes of three boilers. Four of these ducts connect to each chimney, two on a side, by means of a specially designed Y-section which combines the two flues and leads into the portal of the stack. These horizontal flues, while usually independent, may be made continuous from one chimney to the next, but cannot be made to pass by a chimney. The circular uptakes and the horizontal flues as far as the combining uptake are lined with a superior quality of red brick. The circular uptakes are provided with dampers at a convenient height to be reached from the platform over the boilers. In order to provide for the movement caused by the difference in temperature, a very ingenious expansion joint was devised; this consists of a cup formed at the top of the uptake by means of a Z casting bolted to the body of the uptake, the recess thus formed being filled with sand. The upper part of the uptake enters this sand-filled cup and an effectual joint is thereby made.

The six chimneys are of the Alphons-Custodis construction, and each will have an inside diameter of 15 feet and a height of 225 feet above the level of the grates. The walls are 24 inches thick at the base and reduce by 2-in. steps about 16 feet apart to 8⅝ inches thick at the top. A baffle wall 21 feet high is built to prevent the gases from one flue interfering with the gases from the one entering at the opposite side. These stacks are estimated to weigh 1160 tons.

The piping systems are the result of much study to determine the best solution of the problem presented. It has been the aim of the designers to arrange all valves, fittings, etc., in such a relation about the center line of each section that a person familiar with any one section will be able to go to any other section and find a given valve in the same relative position.

That part of the boiler feed water piping from the mains to the boiler feed pumps is low pressure; so is the drip piping from the traps to the drip and surge tanks. The boiler feed water piping from the pumps to the boilers, and the drip piping from the steam mains and cylinders to the traps, is high pressure.

In designing the steam piping system, the ordinary routine has been radically departed from and a distinctly new and interesting scheme has been worked out. In the system adopted the steam header idea has been to a certain extent embodied, but in such a way as to lose itself and a peculiarly new arrangement resulted. It would appear that the work was carried out with the idea to construct, as nearly as would be advisable or logical, a succession of individual plants each complete in itself and connected, as one would say, by electric batteries, in multiple with its neighbor by means of what is called the equalizing line, which can serve the purpose to a certain limited degree of a steam header. The plant can be operated, however, without steam being admitted into this equalizing line at any time unless it becomes necessary to operate an engine unit by steam from any battery of boilers other than its own.

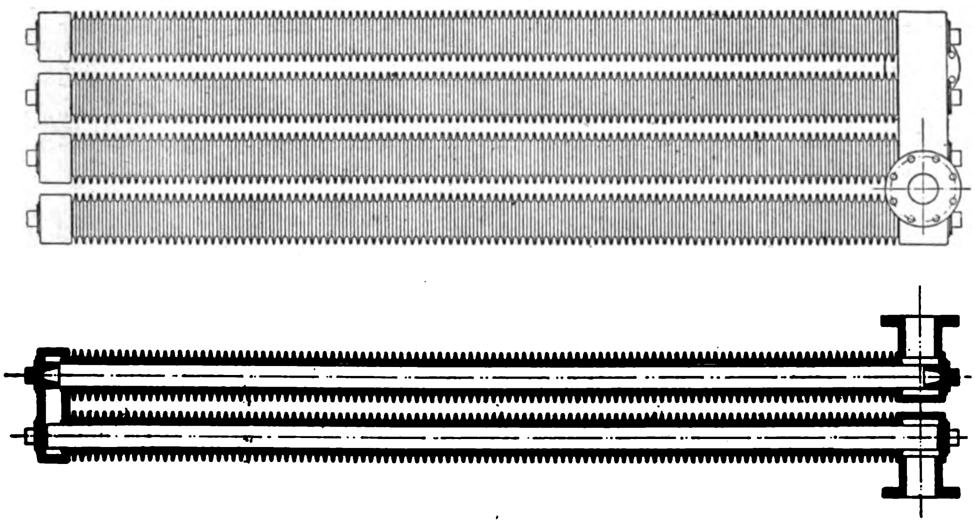

FIG. 8.—SECTION OF FOSTER SUPERHEATER.

It will be noted by reference to the illustrations that equalizing lines of pipe connect the various batteries of boilers; the pipe lines from the individual batteries, which are referred to as main steam headers, terminate at manifolds and these manifolds are connected by the equalizing pipe lines just mentioned. In case it becomes necessary to cross-connect the boiler batteries and the generating units, instead of operating each engine from the battery of boilers corresponding to it, steam from the battery of boilers that is to be cross-connected is delivered through its main steam header into the manifold and there diverted, by means of suitable valves, up or down the building to the point where it is led off to the generating unit. By means of the manifolds alluded to it is possible that the steam from a battery of boilers may be used in the engine unit belonging to this particular battery while steam being used under the conditions just stated is passing through the manifold of the battery in question. The main steam header extends in a perfectly straight line directly over the middle drums of the center boiler of each battery; it starts from a 9-in. x 14-in. x 9-in. cross located over the boilers in the row on the south side of the boiler house, and passes over the north row, where it is increased to a 17-in. pipe. It enters the pipe area through the division wall and is offset 1 foot 2½ inches to bring the manifold in alignment with the center line of the generator. The boilers are connected to the header through 9-in. pipe bends curved to a generous radius between the boiler nozzle and the header and lying in a horizontal plane. Directly over this nozzle the first valve is located; this is an angle valve and opens into a 9-in x 9-in. x 9-in. tee; the straightway of this tee lies in a horizontal position with the branch vertical, and where no superheaters are now used the end away from the valve is covered by a blank flange. Where superheaters are used, the blank flange is removed from the tee and they are connected thereto through a 9-in. angle valve. Fixed in the riser over this tee is a quick-closing 9-in. valve provided with the necessary appliances so that it can be closed from the platform between the boilers. Above this valve is an elbow to which the curved pipe is connected; where this 9-in. curved pipe connects to the header there is another 9-in. valve provided, and by means of elbows these connecting pipes all connect to the headers through the 9-in. x 14-in. x 9-in. cross, thus entering the headers at the side. The 9-in. valves next to the header are all operated from the platform over the boilers by an operating spindle. This description is of the conditions at the row on the south side of the building. At the row on the north side the connections are made to the 17-in. header through a 9-in. x 14-in. x 17-in. cross and a 17-in. x 9-in. tee; with this exception there is no other difference.

Connected to the offset in the header, just after it passes into the pipe area, is a 17-in. gate valve; next a 17-in. x 17-in. tee with the branch looking up. This tee connects to the manifold through a 17-in. special quick-closing balanced angle valve. A 17-in. elbow is connected to the branch of the 17-in. x 17-in. tee, which connects in turn with another special valve and then into a 17-in. x 14-in. x 14-in. cross, located above the special quick-closing angle valve. From each side of this cross there is provided a 14-in. bend of generous radius, in a vertical plane, for the steam supply to each high-pressure cylinder; below this bend is a 14-in. downtake resting on a special elbow, which is provided with a proper support. There is another bend, also in a vertical plane, to each receiver and separator, which it enters at the top. The receivers rest in a horizontal position on the engine foundation; they are well provided with traps. From each receiver to the throttle there is another 14-in. bend, also in a vertical plane, leaving the receiver from the end and connecting to a butterfly valve fitted with a safety stop device.

The main steam piping is of the best quality of wrought-iron or steel lap-welded pipe, provided with a welded flange with a loose wrought flange back of it. For 14-in. and 17-in. pipe and for all pipes between 7 inches and 14 inches, the Van Stone flange is used; on pipes under 7 inches, screwed flanges are used. On pipes over 5 inches in diameter, the flanges have raised seats with ground joints; this means that the joints must be absolutely steam tight.

The boiler feed-water supply may be taken directly from the supply mains or from the storage tanks through an 8-in. branch suction pipe. The water is forced by the pumps through an 8-in. delivery pipe to the feed-water heaters; directly after leaving the pumps, the delivery pipe is furnished with a water relief valve. The piping to the heaters is so equipped with valves that the heaters may be by-passed. From the heaters the piping is carried down into the basement by means of vertical risers, where the system becomes a complete loop lying between the rows of boilers and supported from the boiler floor system. This loop is provided with bends of large radius. There are located at the proper points tees to connect with the brass pipes that feed the boilers and were described with the boilers.

Drip Piping.—All drip pipes from the valves and fittings of the main steam pipes and steam pipes to the auxiliaries are led to the storage tanks, which are located in the feed-water system and help to heat the feed water. From the lower water boxes of feed-water heaters, the steam chamber and the relief valves situated in the atmospheric exhaust and the exhaust from the auxiliaries, drip pipes are carried to an exhaust drain tank, of which there will be provided one for each main engine and one for the turbo-generator set. These exhaust drain tanks connect to suitable pumps which force the water of condensation, which is full of oil, to settling tanks located on the flat roof between the boiler house and engine house. The settling tanks are circular, 48 inches in diameter by about 94 feet long. Here the oil is expected to separate from the water and rise to the surface, whence it is to be removed; the water is to be used for various purposes, such as wetting down ashes, etc.

The water supply system or service piping will make connections with a 12-in. city main at Eleventh Avenue and to a 6-in. main on Fifty-eighth Street and another on Fifty-ninth Street. There will be five 6-in. water meters at the easterly end, connecting with the 12-in. main, and two 6-in. meters at the westerly end; also 3-in. branch meters connecting the plumbing fixtures in the building at eight points along the 12-in. main, between the two groups of 6-in. meters. Connections will be made with eight main storage tanks, each having a capacity of 38,640 cubic feet. Each tank has a 4-in. overflow pipe discharging into the hotwell discharge trench. In case it becomes necessary to use river water, ample provision to do so has been made by means of a salt water pump with a 12-in. suction from a suction well which will be always flooded.

The exhaust piping from the main engines starts from the condensers with a 30-in. relief valve; from this valve the pipe, which is 30 inches in diameter, drops straight down through the main operating floor into the basement, where the exhausts from two units unite into one 48-in. riser which is carried to the roof and terminates in an exhaust head 8 feet in diameter and about 3 feet high. The exhaust pipe is of riveted steel, and is provided with corrugated copper expansion joints. This exhaust pipe has no connection with any feed-water heater. The exhausts from the main steam auxiliaries are combined in 12-in. mains in which the feed-water heaters are inserted; the heaters are by-passed. After leaving the feed-water heater, these exhaust mains connect with the 48-in. main exhaust risers. The exhaust pipe from the turbines extends from the surface condensers with which the turbines are equipped through the basement and thence directly to the roof.

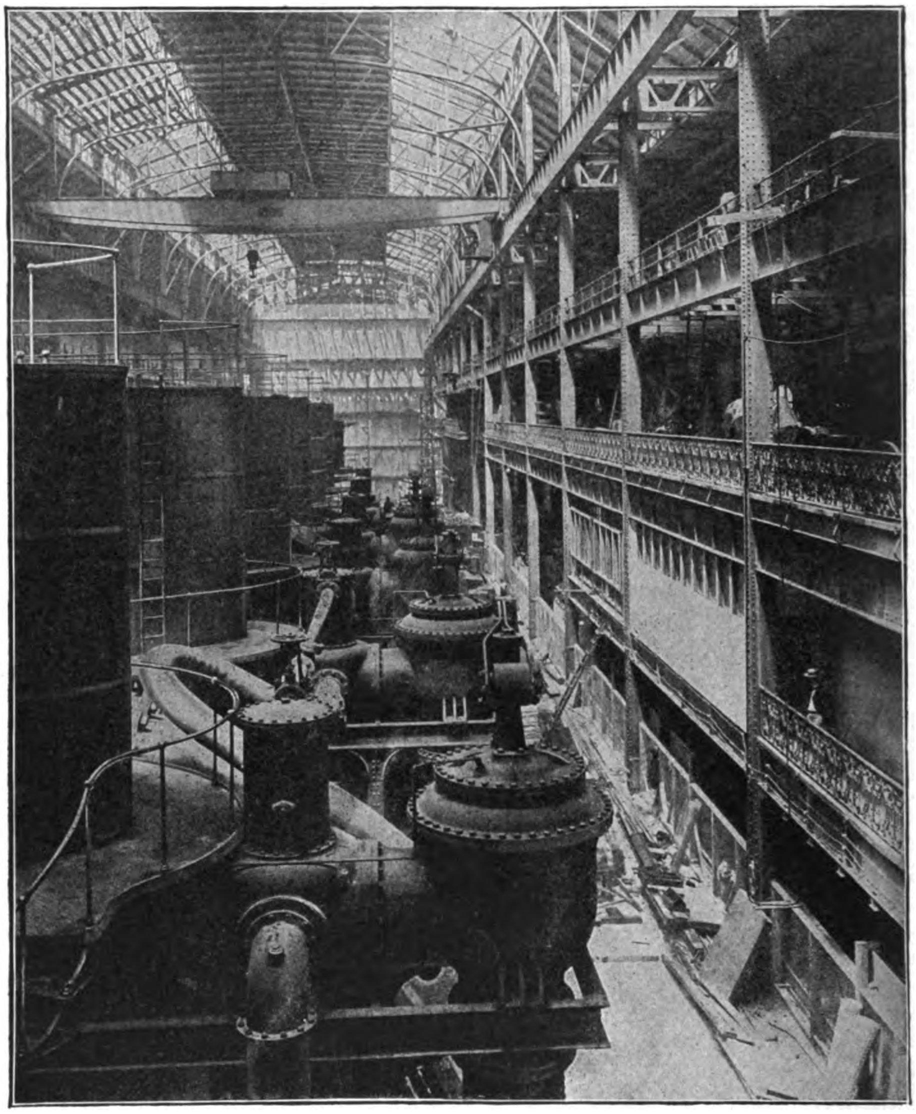

FIG. 9.—OPERATING ROOM IN POWER HOUSE, SHOWING CONDENSERS.

Condensing System.—The condensing system for each engine-generator unit will consist of two Alberger jet condensers with barometric column discharge, two hotwells of concrete and expanded metal into which the barometric columns discharge, one dry vacuum pump, and one cross-compound circulating-water pump. Each condenser is supported on specially designed steel work in front of the engine, and is connected directly to the exhaust outlet of the low-pressure cylinder by means of a single elbow on one side and to the relief valve of the atmospheric exhaust on the other. The condenser head or chamber is 50 inches in diameter and terminates at the bottom in a cone-shaped connection to the tail pipe, while the top is provided with a chamber in which the entrained air and vapor collect and to which is connected the air pipe to the dry vacuum pump. On the side 90 degrees from the steam pipe and the exhaust relief valve the circulating water enters, while directly opposite in the vapor chamber is the air pump connection. The water for use in the condensers will be taken from the North River through a tunnel located under Fifty-eighth Street into suction wells just outside the building. From these suction wells the water is delivered to the condensers by the circulating pumps; which are of the crank and fly-wheel double-acting Corliss type cross-compound, with cylinders of 10 and 20 inches in diameter and 30-in. stroke. The pumps are equipped with two externally packed double-acting plungers 20 inches in diameter, with 30-in. stroke. The normal speed is forty revolutions per minute, but the pumps are under the control of governors which may be set to allow the pump to run at any speed up to 50 revolutions per minute. These pumps have a normal capacity of about 7,000,000 gallons in twenty-four hours and are able to deliver 10,000,000 gallons in the same time if it is necessary. The water enters the pumps from the suction wells through cast-iron suction pipes 24 inches in diameter. These pipes pass under the boiler house basement through concrete-lined trenches, which are covered with cast-iron plates. The delivery pipes from the pumps are 18 inches in diameter, ending in two 14-in. pipes which go around the foundation to the condensers. The circulating pumps of each section are cross-connected in such a manner that either pump can supply either set of condensers in that section. After leaving the condensers, the water passes down through the tail pipe into the hotwells, through the discharge trenches in the basement floor into the discharge tunnel (also under Fifty-eighth Street), and thence back into the river.

The intake tunnel is of concrete. It is 10 feet wide in the clear and 8 ft. 6 ins. high.; the roof and bottom are arched to a radius of 10 feet, with 16-in. fillets in the corners. The side walls are 2 ft. 4 ins. thick and the floor is 3 feet, while the roof is 2 feet thick.

The suction wells are circular, 7 feet inside diameter, and are of concrete to the top of the intake tunnel, 13 ft. 6 ins. above the foundation; above this they are of brick and have a cover of brick arches turned between I-beams. These suction wells are connected with the tunnel by means of openings 7 feet wide and 5 feet high. The bottom of the intake tunnel and the wells is 19 feet below the city datum line or 10 feet below the lowest tide on record. The mouth of the intake tunnel at the river wall is protected by specially designed grids and screens.

The tunnel through which the water from the hotwells is discharged back into the river is located directly over the intake tunnel until within about 100 feet of the river wall, where it branches into two divisions and connects with two timber conduits built into the construction of the pier and carried out 100 feet from the face of the river wall where the mouth of the intake tunnel is located, thus obviating the possibility of the discharge water mixing with the intake water.

The generating units in this power house consist of nine engines and alternators, four turbine-alternators, and five exciter units. The main reciprocating engines are of the type used in the Manhattan Railway power house, which are familiar from having been so often described. However, it may be recalled that they are of the double cross-compound type, with the high-pressure cylinders horizontal and the low-pressure cylinders vertical. The dimensions of the cylinders are 42 ins. and 86 ins. in diameter by 60 ins. stroke, and the speed is 75 revolutions per minute. Both pistons of each engine are connected to one crank-pin. Steam enters the high-pressure cylinder at from 175 to 200 pounds pressure, through a 14-in. pipe, and from there passes into a receiver through a 16-in. pipe, from which it passes to the low-pressure cylinder. This receiver is not steam-jacketed. The normal rating of each engine is 8,000 horse-power, with a 50 per cent. over-load capacity. In one feature these engines will differ from those in the Manhattan power house; they are to have poppet-valves on all the high-pressure cylinders to provide for the use of superheated steam. The usual Corliss valve-gear is used on the low-pressure cylinders. The generators are of the Westinghouse revolving-field fly-wheel type, the field being mounted directly on the engine shaft. They have a capacity of 5000 kilowatts each and furnish 25-cycle three-phase alternating current at 11,000 volts. The machines have forty poles and revolve at 75 revolutions per minute.

In the turbine section provision has been made for four steam turbines, three of which have been erected. These turbines are of the Westinghouse-Parsons type and are direct-connected to 11,000-volt 1250-kw 60-cycle generators, which will supply the current for lighting the stations and subway.

In the same section the five exciting sets have been erected, two of which are steam driven and consist of 400-h.p. vertical cross-compound engines direct-connected to 250-kw. 250-volt direct-current generators. The engines are designed for a steam pressure of 175 pounds and will run at a speed of 150 revolutions per minute. The cylinders are 17 and 27 inches in diameter and the stroke is 24 inches. The other exciter units consist of three 250-kw. 250-volt direct-current generators, motor driven.

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NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION.

The National Electrical Contractors' Association held its fourth annual convention in St. Louis, on September 14, 15 and 16, in the Century Building. All of the meetings with the exception of the morning session of September 16 were held behind closed doors.

At 10 a. m. on September 14 the meeting of the national board of directors was held. This adjourned for the opening meeting of the convention at 2 o'clock in the afternoon. In the absence of Hon. Rolla Wells, Mayor of St. Louis, who was to have given an address of welcome, Mr. E. C. Van Nort, president of the local organization, addressed the assemblage. He stated that the St. Louis organization recognized the fact that members of the convention were in the city first for business and secondly to visit the Exposition. He assured them that members of the St. Louis branch would do everything in their power to make their visit a pleasant as well as a profitable one. After complimenting the officers of the Association on the efficient manner in which affairs had been conducted, he closed by presenting to the convention Mr. E. McCleary, president of the national organization, who responded to the address of welcome.

A business session behind closed doors was held on September 15. The morning of September 16 was taken up by a meeting to which manufacturers and the Western Supply Dealers' Association had been invited. Questions of mutual interest to the three bodies present were freely discussed. Probably the most important discussion was on the subject of state licensing for electrical contractors. Messrs. Eidlitz, Gray, Galloway and Kneider presented the advantages of such a procedure and the question was carefully analyzed in its several aspects. It is a matter of interest to know that the State of Minnesota, as well as the cities of Washington, D. C., and Denver, Colo., have such a system.

Mr. G. W. Sanborn, Indianapolis, chairman of the Underwriters' Committee, was called upon and discussed developments bearing on the Underwriters' rulings.

Mr. W. S. Sisson, of the D. & W. Fuse Company, Providence, was asked to make clear several points as to fuse construction and to speak on the matter of the adoption of the new type knife blade fuse. In response to this invitation, Mr. Sisson said his company preferred to hold to the improved type "A" fuse, but that his company would furnish the new type at the request of the Underwriters.

Mr. W. W. Low, of Chicago, president of the Electrical Supply Dealers' Association, spoke as to the sympathy and interest which should exist between the supply dealers and contractors.

Mr. C. E. Flack, of the American Conduit Manufacturing Company, Pittsburg, was asked to explain the method of construction in its armored conduits.

C. E. Lee, of the Electric Gas Light Company, Boston, made a brief explanation as to the methods of his company in protecting electrical contractors in making sales. At the close of Mr. Lee's remarks his company was heartily commended by the association for its attitude and the individual members of the association were asked to favor this company in their patronage.

Mr. H. B. Coho, of the Keystone Electric Company, Erie, Pa., addressed the association on the advantages of contractors following more universally the practice of making their own installations of electrical machinery.

After the meeting the Electrical Contractors' Association had its last session, which was held in private. Boston was selected as the meeting place of the national convention to be held in 1905.

With the exception of W. I. Gray, former vice-president, who was unable to serve another term, all the old officers were elected for the coming year.

Quite an elaborate programme had been prepared by the Ladies' Auxiliary, of which Mrs. E. C. Van Nort is president, for the entertainment of the ladies accompanying members. On Wednesday morning at 10:30 the ladies met at the Jefferson Hotel for an automobile ride through the residential portion of the city and through the World's Fair grounds. Luncheon was served at the eastern pavilion on Art Hill. At 6 o'clock, the ladies were joined at the Missouri Building by the members of the Association. On Friday afternoon the ladies assembled at the General Electric headquarters in the Electricity Building for a boat ride on the lagoon. At 6 o'clock they again met at the General Electric booth where members of the Association were in waiting to escort them to a 7 o'clock dinner at Blanke's Café on the Pike. During the evening addresses were made by Mr. Charles Eidlitz, past president and organizer of the Association, and by Mr. Lowe, president of the Western Supply Dealers' Association. The event of the occasion, however, was the presentation of a loving cup by the Association, to Mr. Eidlitz. Thus cup, appropriately inscribed, was given as a token of appreciation for past and present services.

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NORTHWESTERN ELECTRICAL ASSOCIATION.

The Northwestern Electrical Association held a short business session at the Forest Park University Hotel, St. Louis, on September 12. After the business had been disposed of, the Association adjourned to attend the meetings of the International Electrical Congress, in many of the papers of which the members were interested; several of the members were also members of the Congress.

THE FIFTH INTERNATIONAL ELECTRICAL CONGRESS.

ST. LOUIS, SEPTEMBER 12 TO 17.

The fifth International Electrical Congress, which met in the Coliseum Music Hall, St. Louis, opened in general session on Monday morning, September 12, with President Elihu Thomson in the chair. President Francis, of the Louisiana Purchase Exposition, delivered an address of welcome, and after appropriate addresses by the presidents of the British Institution of Electrical Engineers, the Italian Electrotechnical Association, and the American Institute of Electrical Engineers, the Congress divided into sections for the reading and discussion of papers. Section "A" was devoted to General Theory; Section "B" to General Applications; Section "C" to Electrochemistry; Section "D" to Electric Power Transmission; Section "E" to Electric Light and Distribution; Section "F" to Electric Transportation; Section "G" to Electric Communications; Section "H" to Electrotherapeutics. As the papers read in Section E related more closely to central station practice than those of any other sections, the proceedings of that section are given rather more fully than the others in the following report.

SECTION A.

The sessions of Section A were opened on Monday, September 12, by the reading of a paper on "The Mechanical Equivalent of Heat Measured by Electrical Means," by Dr. H. J. Barnes. The paper gives a critical comparison of this constant as determined by mechanical and electrical methods, and presents the results obtained by the author by the use of the latter method. The next paper on the programme, "Spectra Gases at High Temperatures," by Prof. John Trowbridge, contains statements of various phenomena observed on discharging a condenser of high e.m.f. through Geissler tubes. Next followed a paper entitled "The Alternating-Current Theory of Transmission Speed Over Submarine Telegraph Cables," by Dr. A. E. Kennelly, who attacks the problem mathematically. The conclusion reached is that the inductance of the receiver should equal the condensance of the sending circuit, and that these values should also equal the ohmic resistance of the circuit. The results depend upon the assumption that the signals consist of a succession of dots sent at regular intervals, but the author expresses the opinion that the effect of dashes would probably be of secondary importance. The concluding paper of Monday's session was that by Prof. Townsend, entitled "The Theory of Ionization by Collision," which was read by title.

The first paper of Tuesday was "Systems of Electric Units," by Professor M. Ascoli. The paper advocates the adoption of a rational system of units as proposed by Professor Giorgi, of Rome. The next paper, "The Absolute Value of the Electromotive-Force of the Clark Cell," by Professors H. S. Carhart and G. W. Patterson, Jr., was in two parts. The first, by Professor Carhart, contains a description of the electrodynamometer used by the authors in their work; the second, by Professor Patterson, contains the mathematical derivation of the expression of the torque of the dynamometer.

In a paper entitled "The So-Called International Electrical Units," Dr. F. A. Wolff discussed the differences in the units as legalized by the principal European and American nations, and the apparent multiplicity of the same units in several individual governments. The author recommends some action that will bring about closer unification.

The reading of these three papers was followed by a joint discussion participated in by members of the American Institute of Electrical Engineers and the British Institution of Electrical Engineers. The speakers were Dr. R. T. Glazebrook, Professor A. G. Webster, Professor H. S. Carhart, Mr. H. E. Harrison, Dr. A. E. Kennelly, Professor John Perry, Dr. F. A. Wolff, Mr. C. H. Sharp, Professor Patterson and Mr. Duddell.

The discussion developed a decided tendency toward conservative handling of the question of changing existing units and standards. Broadly speaking, the discussions were confined to two principal topics: First, the matter of fixing upon a concrete standard of e.m.f. as exemplified by the Clark and Weston normal cells, or of displacing both in favor of the silver voltameter standard; and secondly, the question of rationalizing units in general.

The American speakers were in favor of retaining only the standard cell as the basis of comparison, because of the ease with which it can be handled, and because of recently discovered methods for obtaining pure ingredients; the foreign delegates, on the other hand, seemed disposed to hold to the silver voltameter. With regard to the general system of units, it seemed to be the consensus of opinion that it is too late for any radical change, and that it is best to "let well enough alone."

It was generally agreed that the time is not ripe for recommending legal changes in the accepted value of the e.m.f. of the Clark cell; nor for any action tending toward the replacement of this cell by the Weston cadmium (normal) cell.

At the session of Thursday, September 15, Professor S. Arrhenius presided. The first paper presented was on "The Electric Arc," by Professor C. D. Child. The paper presents an explanation of the phenomena of the arc based on the electron theory. The paper was discussed by Dr. H. T. Barnes and Mr. P. H. Thomas.

"The Absolute Measurement of Inductance," by Dr. E. B. Rosa and Mr. F. W. Grover, was the next paper. These measurements, made at the National Bureau of Standards, were undertaken to determine whether inductance could be measured with sufficient accuracy to establish a basis for determining the ohm in absolute measure. The paper was discussed by Mr. Dryesdale.

Professor E. Rutherford then read a paper entitled "The Corpuscular Theory," by Professor J. J. Thomson. The paper describes experiments made to determine whether there is the same relation between mass and weight in radium as exists in the case of ordinary substances. It has been thought that the peculiar internal conditions of radium might cause a difference in this ratio.

The final paper of the session, "Coherer Action," by Dr. K. E. Guthe, was read in abstract by Mr. A. S. McAllister.

The first paper of the final session on Friday, September 16, was entitled "The State of Our Knowledge Regarding the Earth's Magnetism and Most Recent Remarkable Magnetic Storms," the author being Dr. L. A. Bauer.

In the discussion which followed, Messrs. Glazebrook, Steinmetz and Bauer participated. The discussion turned mainly to the question of protecting magnetic observatories from disturbances by leakage currents from power circuits.

Dr. Svante Arrhenius then presented his paper "On the Relation Between the Sun's Rays and Electromagnetic Disturbances on the Earth."

The discussion was participated in by Messrs. Rutherford, Steinmetz and Arrhenius. The discussion was followed by a paper on "Radioactive Change," by Professor E. Rutherford, which had the form of a report of further work on transition stages of radium.

Professor A. G. Webster followed with a paper entitled "Report on Recent Developments in Electrical Theory." This is a long mathematical paper, not capable of being abstracted, and dealing with Lorentz's electron theory.

SECTION B.

The sessions of Section B were opened on Monday by the presentation of a paper by W. M. Mordey, on "Eddies and Hysteresis in Iron," which was read by Professor Samuel Sheldon in the absence of the author. The author has found, experimentally, that even with the sheet steel of small thicknesses the eddy current losses are quite large in comparison with the total iron loss, and are by no means negligible, as is frequently assumed. The eddy losses do not vary as the square of the thickness of the sheets nor as the square of the frequency. In fact, the eddy losses are found to vary according to the 1.6 power of the frequency, as is true of hysteresis and as the first power of the thickness of sheets. This is due to the inductive effect of the electric circuit through which the eddy currents must flow. Thus, in the increase of either the frequency or the thickness of the sheets, the skin effect becomes more pronounced, the net result being that the eddy current loss follows a law more or less the same as applies to hysteresis, depending on the relative values of the hysteretic constant of the iron and the electrical conductivity of the material. It is suggested that the proper method for testing for iron loss is with a wattmeter, using sheets of commercial size.

In his paper on "Magnetic Viscosity," which was read by Mr. W. I. Slichter, Mr. M. R. Jouraust described experiments to show the presence of an appreciable time lag in the building up of magnetism after the application of the magnetomotive force. This effect is found to be more prominent if the magnetism is taken from a certain small positive value to a similar negative one than when decreased, through the same range, from a large positive to a small positive value. It is attributable to the sluggish movement of the molecular magnets at the period of instability. It is found also that there is generated by the change in flux a local current which tends to retard the change. With large masses of steel the viscosity effect is quite noticeable, but with commercial laminations it is inappreciable. The effect has been noted with other magnetic materials, as ferro manganese, and especially in cast metals.

In discussing this paper, Professor Steinmetz stated that it had been frequently assumed that the loss per cycle due to hysteresis depended not only on the maximum density, but also on the rapidity of reversal. Investigations have shown that for commercial frequencies hysteresis is represented by so much energy per cycle and is practically independent of the frequency. A fact which has a bearing on engineering work is that the flux produced by a certain magnetomotive force is less for alternating than for direct current. This fact is of importance with alternating current railway motors and various types of meters. Professor H. J. Ryan called attention to the necessity of observing the shape of the curves in alternating current work, and stated that results obtained with wattmeter tests of losses and Duddell oscillograph records of shape of waves would furnish valuable information for investigators of these complex phenomena. Mr. Ford reported the results of tests made at Columbia University to determine the effect of eddy currents upon the hysteresis loop. Experiments had shown that the sharp points of the loop were not rounded, due to any increase of frequency, but that any rounding observed could be attributed to eddy currents in the iron. In commenting on Mr. Mordey's paper, Dr. Sharp said that true test results could best be obtained with iron sheets built up to convenient commercial size, a wattmeter being used for finding the iron loss. For minimum loss there should be used iron having high specific resistance and low hysteretic constant. Professor C. A. Adams drew attention to the fact that the shape of the curve showing the relation of iron loss and frequency would depend upon the constants assumed for the hysteresis and for the eddy loss. He stated that the results of tests which had been made upon commercial iron sheets when subjected to various densities at different frequencies were quite consistent for frequencies between 25 and 300 cycles per second, when the assumption was made that the eddy loss varied as the square and the hysteresis as the 1.6 power of the density, proper values for the constants being thus determined. With reference to the determination of the hysteresis loop of transformers, Mr. Duddell outlined a most interesting method involving the use of an oscillograph for showing the loop directly.

Dr. C. H. Sharp read his paper on "The Equipment of a Commercial Testing Laboratory," which dealt with laboratories intended not for purposes of instruction, but as commercial enterprises. Thus the prime requisites are dispatch, accuracy and economy. This paper was not discussed.

Dr. C. P. Steinmetz abstracted the paper of Mr. Albert Nowon on "Electrolytic Rectifiers—An Experimental Research." It is impossible to obtain a unidirectional electromotive force by magnetic induction with stationary apparatus, due to the fact that a changing flux which produces an e.m.f. of one sign when increasing in value, must give an e.m.f. of reversed sign when its value is on the decrease. Therefore, electromagnetic apparatus for producing unidirectional e.m.f. must be of the open magnet circuit type, and one part must slide or rotate with reference to the other, and in general a commutating device must be employed. With the electrolytic rectifier or the so-called electrolytic valves, the current is allowed to flow more freely in one direction than in the other, the effective resistance being small for current in one direction and large for current in the other direction. When the valve effect is perfect the effective resistance is low for current of one sign and is infinite for current of the other. A certain hysteresis effect is produced at the surface of the electrode, the process occurring at this place not being entirely reversible and resulting in an energy loss. This loss is constant and forms the no-load loss of the rectifier. The efficiency is determined by the value of this loss and an additional loss which varies with the square of the local current, due to the resistance of the circuit through which the current must pass. A single rectifier gives an interrupted pulsating current. By the combination of several rectifiers whose currents are superposed or which are used with energy storing devices, a truly unidirectional and constant e.m.f. or current may be obtained. The proper arrangements to be used are described by the author.

The paper of Mr. B. A. Behrend on **The Testing of Alternating-Current Generators** was read by Mr. W. I. Slichter. The paper describes an improved method for testing alternating-current generators and synchronous motors under full-load conditions, without actually having to place the machines under full load. Instead of having to divide the armature into two sections, as suggested first by Mr. Mordey, Mr. Behrend splits the fields into two sections and connects these sections in such a manner that the e.m.fs. induced in the armature are in opposition. Test curves given in the paper show that the method produces results closely equivalent to loading the machines.

Professor H. J. Ryan, on account of the great convenience and efficiency of the method proposed by Mr. Behrend, suggested that a systematic comparison of results obtained by actually loading various machines and by calculations based upon the method proposed would be most interesting and instructive as furnishing constants of design of different types of machines. Mr. W. L. Waters expressed his doubt as to the accuracy of the results to be obtained from machines of widely different types by the Behrend method. He has found that very good results may be gotten from passing direct current through the divided armature circuits and that the vibration of the machine, while of appreciable magnitude, does no harm. On account of the field coil circuit being cut by the magnetism, due to the direct current in the armature, a short-circuit current is produced in the field coils, and the effect of this action must be taken into account. The method of loading the machine with inductive coils for a short time serves to heat up the machine, while the power-factor being low the energy consumed is small and the results are quite satisfactory. Mr. D. B. Rushmore stated that an asymmetrical connection of the armature conductors so as to give unbalanced e.m.f. in the locally closed armature circuit had been found to give good results. In fact, commercial accuracy was obtained by determining the regulation from the short-circuit and open-circuit tests, using either the magnetomotive force or the electromotive force methods. Mr. Steinmetz laid emphasis on the fact that the best method of testing an alternator for efficiency, temperature rises and regulations is by actually loading the machine. Such procedure is practically impossible with large generators and methods of calculation must be used. Experience has shown that the calculated results were even more accurate than the observed results due to the difficulties in controlling the condition of a test under load. An excellent plan is to operate the machine on short circuit for a certain time and on open circuit with excess excitation for a certain time, in order to get the full temperature rise. The length of time for each condition of test depends upon the type of machine, and experience shows the values to be assigned to each. Professor C. A. Adams stated that whether the electromotive force method or the magnetomotive force method should be used depended upon the type of machine being tested. The electromotive force or reactance method had been found good for all types of machines.

On Tuesday, September 13, Sections B and F met in joint session. The first paper of the day, by B. J. Arnold, on "Some Early Work in Polyphase and Single-Phase Electric Traction," referred to the history of the work done by the author since 1896 in the solution of traction problems.

Professor C. P. Steinmetz then presented his paper on "Alternating Current Motors," which is an elaborate general mathematical treatment of the subject. The paper on "Single-Phase Motors," by Max Deri, was read by Mr. Slichter, this also treating the subject from the mathematical standpoint. Marius Latour presented his paper on "Single-Phase Motors," which discussed in particular the compensated repulsion motor upon which he has been working for several years. In regard to the commutation, he showed that the e.m.f. in the coil short circuited by the brush has two components, one due to transformer action and the other due to speed. The former is practically constant, while the latter varies with the speed. At synchronism the two components are equal in value and, being opposite in phase, the resultant is zero, so that the commutation at this speed is perfect. The paper disclosed a method for improving the commutation at all speeds by use of coils connected electrically in shunt across the power circuit and placed mechanically so as to generate a proper counter e.m.f. in the coil under the brush, thus eliminating the sparking troubles. Dr. O. S. Bradstad's paper on "Theory and Operation of Repulsion Motor" was abstracted by Professor C. P. Steinmetz. The paper is mathematical in character, a general equation for the repulsion motor being derived, and the conditions which must be fulfilled to give maximum power, maximum torque or maximum power-factor are discussed. A method of determining the characteristics of the machine from open circuit and short circuit tests is given. This method corresponds closely to the one which is applicable to induction motors and transformers and to the one which is used in the synchronous motors and generators. The author uses the method of complex quantities and gives diagrams to represent his equations. Professor Steinmetz abstracted briefly the paper by Ernst Danielson on "The Theory of the Compensated Repulsion Motor." The author determines the distribution of the magnetomotive force and the flux, and in this way derives a general equation for the machine. He treats of the compensation and of the conditions for obtaining good commutation and reports the results of tests on certain motors. The paper is largely mathematical and cannot be readily abstracted. Mr. P. M. Lincoln presented a paper on

Transmission and Distribution Problems Peculiar to Single-Phase Railways.

An apparent handicap for the single-phase in comparison with the three-phase transmission system is the fact that the copper required is in the ratio of 4 to 3. This ratio holds true on the basis of equal potential between wires, but if equal normal potential to ground be considered the basis then the single-phase and the three-phase are on an equality. A polyphase generator is cheaper by 30 per cent than a single-phase machine of the same capacity, hence it is advantageous to use polyphase generators for supply, dividing the load as equally among the phases as possible. A disadvantage is found in thus operating from a polyphase circuit, since if one of the three wires be taken away, the sum of the static potentials no longer remains at zero, and static induction will take place on neighboring (telephone) circuits without the possibility of correction by any method of transposition. After discussing the application of Kelvin's law for the determination of maximum commercial economy of conducting material and the relation of the voltage drop to the spacing of transformer stations, the author concludes that there is no golden rule for the determination of the spacing and capacity of transformer stations or of the size of the conductor. It is a matter of compromise between various elements, some of which point in one direction and some in the other, and is a matter which must be determined by engineering judgment rather than by any inflexible law.

The paper by Dr. F. Niethammer on "Alternating vs. Direct-Current Traction" was presented to the members in printed form and was not read, owing to its great length.

In discussing the relative advantages of three-phase and single-phase motors as to the torque exerted by each, Mr. E. K. Scott compared the machines to three-crank and single-crank engines. The polyphase and the direct-current motors give constant torque, but the torque of the single-phase series motor is pulsating. In order that the wheels of an electric locomotive should not slip when equipped with alternating current series motors, it must be sufficiently heavy to adhere to the track for maximum torque, and, therefore, the locomotive must be larger than when direct-current motors are used. In a three-phase, delta-connected system, if one transformer is damaged the other two will carry the load, but in a single-phase system the loss of one transformer shuts down the circuits. Mr. B. G. Lamme explained why the air-gap of a single-phase series motor could be made so much larger than that of induction motors without detrimental effect upon the power factor at operating speeds. A fact which seems little appreciated is that with the single-phase motor both wattless and energy current produce torque, while with the induction motor only the power component of the current represents torque. Thus a low power factor at starting does not indicate poor torque. On the contrary, the lower the power factor the better the motor, since all power current indicates internal losses. The Westinghouse Company uses the directly compensated motor with exact compensation. The method of determining the degree of compensation is to short circuit the compensating coil while current flows in the armature. If the compensation is excessive current will flow in the local circuit in one direction; if too weak, the current will flow in the other.

In discussing the relative advantages of single-phase and polyphase induction motors, Professor C. P. Steinmetz stated that the operating range of the single-phase motor is much more limited than that of the polyphase. The polyphase motor could be used for railway work, but the single-phase is unsuited except by some such scheme as that used by Arnold. The commutator motors are not limited as to speed range, the torque varying inversely with change of speed as with the direct-current machine, and closely as the square of the current. A polyphase motor gives a torque varying as the first power of the current; the single-phase commutator motor shows the best torque efficiency. In reply to the criticism of Mr. E. K. Scott, Professor Steinmetz stated that single-crank tandem compound engines were found to be as good as two-crank engines, the pulsating torque not being objectionable. He directed attention to the fact that there is no dead-center with a series motor, the torque pulsating at a rate depending upon the frequency and quite independent of the speed. As to the type of generator to select, a polyphase generator is somewhat smaller than a single-phase machine and polyphase motors are preferable for stationary duties. It seems best to generate polyphase and distribute single-phase. The ideal system is single-phase for both generation and distribution. Mr. A. H. Armstrong stated that railways being installed must conform as nearly as possible to existing systems.

Mr. H. W. Leonard stated that he had early been an advocate of the single-phase system for railway work, and described the electric locomotive known by his name.

Commenting on the Bragstadt paper, Mr. W. L. Waters remarked that, while the best method of representing the performance of motors is by means of graphical diagrams, the computation connected with single-phase motors required analytical equations, and it is best to use both the graphical and analytical methods. In regard to the transmission circuits, it is evident that, compared upon the proper basis of e.m.f. to neutral point, the single-phase system is equally as good as the three-phase.

Mr. P. M. Lincoln stated that the Westinghouse Company had at first advocated a low trolley voltage which would permit of the use of insulation when available for street railway work. Thus, standard insulators were adequate for 1,000 volts, but were too weak for 2200 and 3300 volts. At present, however, trolley insulators conforming to standard practice are available which will withstand the latter pressures.

At the opening of Section B, on Thursday, Professor S. P. Thompson not being present, Professor C. P. Steinmetz abstracted his paper on "Plunger Electromagnets," which dealt with the problem of the proper design of plunger magnets so as to give a force which varied but little throughout a large range of stroke. The author shows how to calculate the reluctance of the magnetic path and to determine the m.m.f. necessary to produce a given flux. The problem, which is quite easy for closed magnetic circuits, becomes quite complex when open circuits are used, due to the so-called demagnetizing effect of the end poles. He explains the method of ascertaining the surfaces to be given to the coil which must dissipate a certain amount of heat when the magnet is used either for constant service, temporary service or intermittent service. The method of magnetic images is employed. It is shown that the equivalent effect of a long magnet may be obtained by means of plates at the pole ends.

The paper by Professor E. B. Rosa, Dr. M. G. Lloyd and Mr. C. E. Reid, on "Wave Shape and Meter Indications," represented the results of tests made at the Bureau of Standards to determine the effect of variation of wave form of e.m.f. upon the indications of the meter.

Professor H. J. Ryan presented his paper on

The Design of Insulators.

In the design of insulators to withstand high electric pressures the following methods and data are useful: (1) A convenient system of fixing quantitatively the flux electric force produced by an e.m.f. in a dielectric, causing the electric strain therein. (2) The permeability of an insulation to flux the electric force produced by an e.m.f. (3) The density of flux of electric force which the ultimate electric strength of an insulation is called upon to withstand and at which rupture occurs. (4) Expedients that localize the application of the electric strain within those portions of an insulating system that are most powerful and capable of standing the total strain. (5) Experimental methods for testing the dielectric materials to ascertain the proper construction so as to secure their breaking strains, that is, the densities of electric force flux at which their ultimate rupturing strength is developed, and for testing completed insulations or insulators to determine the manner in which they will satisfy the requirements and to determine the design factors. (6) Factors of safety as determined by trained judgment. After discussing each of these topics in detail the author calls attention to the fact that a far less proportionate use of mathematics can be made in determining necessary dimensions in the design of insulation than is the case correspondingly for either of the other two components of electrical machinery and apparatus, viz., the circuits accommodating electric current and magnetism.

In commenting on the paper Mr. D. B. Rushmore expressed his appreciation of the valuable work done by Professor Ryan in placing the insulation of electrical machinery on a scientific basis in so simple a manner. He referred to the fact that while formerly cotton covering was depended upon for insulation in transformers, the tendency to-day is to use some separator for the conductors and depend entirely upon oil for insulation. In reply to Mr. Rushmore's question as to the existence of dielectric hysteresis, Professor Ryan related his experiences with the heating of dielectrics, which seemed to show that, while such hysteresis might be present, the heating could in every case be attributed to local weakening of the dielectric under excess stress which rendered it conducting, after which it heated rapidly and finally gave way.

Electric Motors in Machine Shop Service was the subject of a paper presented by C. Day. The author considers the subject from the standpoint of the engineer. The motor-driven tool of the future should be not a combination but a unit suited for certain specific ends. When a machine is purchased, the customer should have the assurance that the drive has been given the same care in design and construction as any other part of the machine. Apparatus should be primarily designed to be satisfactory in the hands of average workers. When equipping machines of old design with motor drive each one should be considered separately with regard to the special line of work it handles. Systems now on the market for obtaining adjustable speed are field weakening alone, double commutator motor combined with field weakening, Edison three-wire, unbalanced three-wire and four-wire multiple voltage systems, each combined with field weakening. The conditions which must be met by the machine builders necessitating the selection of a type that does not require for its operation special auxiliary apparatus are pointed out. While motors operating on two wires and giving a range as high as 4 to 1 by means of field weakening do not at present give as good all around results as those operating on the multiple-voltage and three-wire systems, their adoption by manufacturers is certainly justified in many instances. After the reading of this paper, Sections B and E combined to discuss Col. R. E. B. Crompton's paper on "Standardization of Dynamo Electric Machinery," which had been read the day previous.

Mr. J. W. Lieb, Jr. called attention to the frequency of 50 cycles which the English committee had suggested to fill the duty performed by the American 60 cycles and thought that the two countries should combine on a common value. Professor C. P. Steinmetz remarked that the difficulty in specifying standard frequencies is due to the fact that there are three supreme courts for discussion, the electrical engineer, the customer and the builder. Fifty cycles had been tried in this country in '92-'93, but practice crystallized toward 60 cycles, which value has been the accepted one here for the past six years. It does not seem possible that America could adopt 50 cycles, though perhaps a common frequency for both England and America could be found in 60 cycles. Colonel Crompton related the reasons for the suggestion of 25 and 50 cycles as standard frequencies. Fifty cycles can better be used for rotary converters than 60 cycles, while a lower frequency, such as 40, while better for converters, is not suited for general illumination. The ratio of 50 to 25, the best frequency for general power purposes, is just 2 to 1, and furthermore, Germany has adopted 50 cycles.

Mr. C. F. Scott stated that from personal observations he had found a great need for standardization in England, where the number of frequencies in use is simply appalling. In America, the conditions differ from those in England, since a few large companies control the manufacture of machinery and the engineers have early recognized the advantage of standardization. A danger which may follow standardization is a checking of progress of development. The suggestions should be given as a guide, not as a law. Dr. R. T. Glazebrook wished to correct the impression that in England the suggestions made would become law, since in reality there could be no rigid rules laid down and no supreme council to see that they were followed. The suggestions would be availed of in just so far as they proved proper for the conditions existing.

Professor F. B. Crocker related his early experience in standardizing apparatus. President R. K. Gray, of the (British) Institution of Electrical Engineers, agreed with Mr. Scott as to the suggestion for guidance and not law in connection with the standardization, which should be made in conformity to the wishes of all concerned and not involve the necessity of compulsion in its adoption.

Professor Moise Ascoli expressed his appreciation of the work being done, and stated that though no standardization had as yet been attempted in Italy, the engineers of that country would profit by the suggestions now being made when they undertook a similar task. Col. Crompton, in closing the discussion, thanked the Congress for the attention paid the subject and expressed his pleasure at the general accord of opinion of the American and English engineers as to standardization, the only difference noticed being in regard to the frequency. He stated that the Board of Trade, which had relatively considerable power in England, had in the past issued rules which were valuable for the protection of lives from electrical dangers. No compulsion had been used and no obstruction to progress had been offered. Recently the upper limit to low-tension voltage had been raised to conform to improved conditions of insulation.

At the opening of the final meeting on Friday, the paper presented by Mr. F. J. Eichberg on "Single-Phase Electric Railways" was presented in abstract by Professor C. P. Steinmetz. The paper described the type of single-phase commutator motor known as the Winter-Eichberg machine, which gives the series motor characteristics. The motor possesses two sets of brushes, mutually at right angles to each other. One set receives the energy current by transformer action and the other exciting current by direct series connection in the circuit. It was shown by Professor Steinmetz that the general type of commutator motor contains four circuits, two on the stator and two on the rotor; of these, only two are necessary for operation, one for energy and the other for excitation current. With the type of motor described three circuits are used, two of which are on the motor. The motor is quite similar in operation to a repulsion motor. Mr. W. I. Slichter abstracted the paper by M. Andre Blondel on "Calculations and Tests of Alternators," whch treated of the various methods of determining the performance of an alternator either by calculation or by test. Where two similar alternators are to be tested a convenient method is to connect them together mechanically and shift the relative phase of the two so as to cause a current to circulate locally through the armatures. A third machine which drives the set supplies the losses of the machine, while the motor machine of the set feeds back energy to the generator through the coupling shaft. He mentioned also the method of dividing the pole windings of a single machine into two groups and varying the current of the groups. This gives a motor-generator effect to the armature which is equivalent to loading the machine, where a large number of poles is used, but leads to error with machines having but a few poles. Mr. Slichter abstracted also the second paper by M. Andre Blondel on a somewhat similar subject, "Reaction in Alternators." The method followed by the author involves the determination of the magnetomotive force of the armature ampere turns and dividing the leakage flux due thereto into two components, the demagnetizing and the distorting. Account is taken of the effect of saturation of the armature and field cores. For single-phase machines the alternating magnetomotive force is resolved into two components, each of half value, revolving uniformly in opposite directions on the armature core, one, therefore, being stationary in space and the other traveling at double speed. Thus the reaction is pulsating in each machine. The author treats of the effect of the variation of the number of slots for single-phase and polyphase machines and shows methods for reducing the distortion. Mr. V. Karapetoff called attention to the fact that an exact treatment of the regulation of alternators must take into account the armature resistance, armature reactance, demagnetizing and cross magnetizing effects of the armature current. The reactance of the armature windings consists of the self-inductance of the section in the slots and of the section in air and the mutual inductance of the coils. It is not possible to combine all of these in one effect.

Mr. W. I. Slichter abstracted the paper by M. Paul Boucherot on "Kinetic Variation of E.M.F. in Dynamo Electric Generators and Its Influence on Their Operation in Parallel," which dealt with both direct and alternating-current generators, the dynamic action of a pendulum being the basis for the treatment with alternators. This paper was not discussed.

Professor C. A. Adams presented his paper on "Leakage Reactance of Induction Motors," which was a report on an experimental investigation of the effect on the leakage reactance of shifting the relative positions of the rotor and stator cores. Mr. D. B. Rushmore stated that the facts brought out were applicable to all classes of machinery. It is only in recent years that the designers of direct-current machinery have been considering the effect of the self-inductance of the armature coils. While the results sought are different in the several cases, the facts involved are the same in each. In reply to a question by Mr. Karapetoff, as to the effect upon the current taken by the induction motor on shifting the rotor and as to methods of separating the primary from the secondary leakage reactance, Professor Adams stated that the variation of current with a cage-wound rotor would be very slight indeed, due to the prime relation between the primary and secondary number of slots, but that with certain coil-wound secondaries the variation was as much as 30 per cent. As to the calculations of the reactances, they had been found to check within 5 per cent of the test values.

Mr. D. B. Rushmore presented his paper on "The Regulation of Alternators," which gives by description, inference and reference a summary of work done and of the methods commonly used for determining regulation and the results of very careful tests on widely different types of machines. The paper forms a contribution of real value concerning actual operation under many different conditions. The results of the tests are given in 27 curve sheets, which are accompanied by complete design data in order that the many possible valuable deductions may be made therefrom. The paper is especially valuable on account of the test data, in obtaining which the greatest care was taken with methods and instruments and on account of the fact that only those observations which could be repeated have been recorded. Mr. C. V. Dryesdale described a method of determining the regulation by use of the short circuit and open circuit characteristics. In this method there is plotted a third curve which represents the square of the magnetic reluctance of the machine, found as the ratio of field current to armature e.m.f. at full speed. By locating certain points on this curve by use of the short circuit characteristic at a given load current, the terminal e.m.f. of the generator is found on the excitation characteristic. The method takes into account the change in reluctance of the magnetic path and is, therefore, preferable to a method which neglects such change.

Recent Development in Compound Alternators with Alternating Current Self-Excitation.

This paper by A. Heyland was read in abstract by Mr. A. S. McAllister.

The main point of the system devised by the author is that single-phase or polyphase alternating current generated by the machine is led directly to the field windings for excitation and for compounding by means of a peculiar commutator. By the interposition and suitable inter-connection of transformers, or by certain circuit arrangements in a single transformer, the exciting current of the machine is taken off in shunt to the main winding and the compounding current in series, and so conducted to the commutator that the exciting current entering the field winding remains approximately constant for all loads, while the compounding current increases and decreases with the wattless component of the main current. The armature reaction can be annulled and the drop in voltage compensated for or the machine may be over compounded. In the latest constructions the field winding is divided into groups which are connected to the commutator in parallel to one another. By placing cross connections at the end of the conductors, the current is not interrupted, as was the case in the earlier arrangement, which has been abandoned for practical and constructive reasons. In a recent compounding connection, the polyphase exciting current is generated in three auxiliary coils which are located on the stator. In the same slot in which the auxiliary winding lies, there is placed a part of the main winding, the respective coils being, however, connected in opposite directions to the remaining part of the main winding. With a suitable choice of the number of turns of the compounding coils of the main winding, there can be obtained in this manner a complete compounding without a compounding transformer.

Mr. V. Karapetoff remarked that Mr. Heyland had devised numerous new types of machines in recent years, all of which involved the use of a special commutator. He explained that the most valuable feature of recent developments resided in the means for increasing the excitation of the generator directly with the wattless component of the armature current, while the power component had no effect upon the excitation. He pointed to the fact that periodically new and improved schemes were proposed by Mr. Heyland, a recent one involving the use of a separate exciter for the main field current while retaining the special commutator for counteracting the effect of the wattless component of the load current. A recent scheme consisted in causing the wattless component of the load current of generator to increase the field strength of a separate exciting generator. Professor Adams stated that the self-exciting features introduced by Mr. Heyland might prove advantageous for small plants, but they necessitate undue complications for large plants and central stations, where the use of separate generators for excitation is preferable. Mr. C. V. Dryesdale remarked that the Heyland generators operated very satisfactorily under test, and he thought that the auxiliary excitation of the exciting generator suggested many inviting possibilities. Mr. Rushmore said that schemes for compounding which are carried out on the generator itself are in general expensive and complicated. Methods are now in satisfactory use for performing this work external to the armature circuits of the generator and these seem to be preferable.

The paper by H. M. Hobart on "A

Method of Designing Induction Motors" was given by Professor H. J. Ryan.

Mr. D. B. Rushmore remarked that the author, being a designer of machines, was most liberal with his information, being a frequent contributor to the technical press. He felt that the electrical engineers owed a debt of gratitude to Mr. Hobart for the paper at hand, which so admirably presented the requirements of a good design for induction motors based upon actual experience with the machines. The papers now being read before conventions of engineers represent, he said, a change of attitude of the members of the profession. Much good is being accomplished through the free interchange of ideas which were previously held as trade secrets. Engineers have ceased to withhold information, and advantages have thereby been gained on all sides.

SECTION C.

Immediately after the inaugural general meeting of the Congress, Section C was organized with the following officers: Prof. Henry S. Carhart, chairman, and Mr. Carl Hering, secretary. The only paper presented at Monday's session was that of Prof. Theodore William Richards (Harvard University) on the relation of the hypothesis of compressible atoms of electrochemistry. In the absence of the author it was read by Dr. G. W. Patterson, and discussed very briefly by Prof. Carhart and Prof. Patterson with respect to the application of Richards' hypothesis to the Gibbs-Helmholtz equation.

In the absence of the president and secretary of the section during Tuesday's session, Dr. W. D. Bancroft acted as chairman and Mr. S. S. Sadtler as secretary. The first paper was presented by Mr. J. Sigfrid Edstrom on "Electric Extraction of Nitrogen From the Air." The paper dealt with the methods of Prof. C. Birkeland and Mr. S. Eyde, of Christiania.

A paper was then presented by Dr. Wilder D. Bancroft (Cornell University) on the "Chemistry of Electroplating." This discussion was opened by Dr. E. F. Kern, who read a long communication by Mr. A. G. Betts, criticising several of Dr. Bancroft's generalizations. Dr. Louis Kahlenberg emphasized that the chemical make-up of the solution is the vital factor. Prof. C. F. Burgess said whether one calls a deposit good or bad depends much upon the standpoint whether one is a refiner or an electroplater. In his reply, Dr. Bancroft said that the object of his paper was to give some distinct generalizations which can be tested by experiment and which can be proven to be either right or wrong.

Prof. F. Haber's and Dr. L. Bruner's paper on "The Carbon Cell" was then read, in absence of the authors, by Prof. C. F. Burgess. The discussion was opened by the reading of a communication by Mr. C. J. Reed, who thought that the authors had not given sufficient proof for their theory that the Jacques cell is essentially an oxygen-hydrogen gas cell. He believes that Ostwald's explanation of the chemical action in the cell is the correct one. Some brief remarks were made by Prof. Bancroft and Prof. Kahlenberg.

The next paper was presented by Dr. Louis Kahlenberg (University of Wisconsin) on "The Electrochemical Series of the Metals." In the discussion of the paper Prof. W. D. Bancroft and Dr. H. E. Patten took part.

Mr. A. G. Betts' and Dr. E. F. Kern's paper on the "Lead Voltameter" was then read by Dr. Kern. There was no discussion.

The last paper of the session was Mr. James Swinburne's (London) paper on "Chlorine in Metallurgy." In the brief discussion which followed Dr. W. D. Bancroft referred to the trouble which electrolytic alkali manufacturers have with the chlorine generated since there is an overproduction of bleaching powder. Mr. S. S. Sadtler said that Mr. Swinburne's scheme of treating complex sulphide ores is of great simplicity on paper, but on a large scale there should be many complications.

At a special meeting of Section C, held in the Library Hall of the Administration Building in the World's Fair, Dr. Hans Goldschmidt lectured on aluminothermics. There was no meeting of Section C on Wednesday.

The first paper of Thursday's session was presented by Dr. K. E. Guthe (National Bureau of Standards, Washington) on the "Silver Voltameter." At the conclusion of his paper Dr. Guthe emphasized that as far as accuracy and possibility of reproducing the instrument are concerned, the silver voltameter is as good as a standard cell; yet the latter may win out in the end for practical reasons. In the discussion Dr. Glazebrook gave an outline of the work which has been done in the British National Laboratory. Prof. W. D. Bancroft suggested to try a cathode inside a porous cup and the use of a rotating cathode. Mr. S. S. Sadtler suggested the use of silver nitrate as electrolyte. Prof. Carhart spoke of his early experiments in connection with this subject.

A paper, entitled "A Study of the Materials Used in Standard Cells and Their Preparation," of which Prof. H. S. Carhart and Prof. Geo. A. Hulett (University of Michigan) are joint authors, was then presented by Prof. Carhart.

Dr. Paul L. T. Héroult (La Praz, France) then presented a paper on "The Use of the Electric Furnace in the Metallurgy of Iron and Steel." He first gave a review of his work in making ferro-alloys and in reducing iron from ores, and discussed especially two methods of utilizing the electrical energy to the best advantage. He expressed the view that the electric furnace for the reduction of iron ores is applicable only under certain conditions and is not supposed to supersede the blast furnace except where electric energy is very cheap.

In the discussion which followed, Dr. J. W. Richards spoke in highly complimentary terms of Dr. Héroult's work and discussed the various special uses to which the electric furnace may be put in iron and steel metallurgy. Mr. W. McA. Johnson said that this is another example of the general rule that the electric current is most useful in metallurgy for the finishing touches.

Dr. A. E. Kennelly's and Mr. S. E. Whitney's (Harvard University) paper on the **Present Status of the Edison Storage Battery** was then read by Mr. Whitney.

This was an historical account of the development of the nickel-iron alkaline storage cells from the beginning of the work of Mr. Edison in 1898 to the present date. The first cell, named type C, was put into service in 1900; type D was first completed in May, 1903. A further modification in the cells resulted in type E, the latest type. Each type of cell is described and its performance and defects noted. The characteristics of type E are dwelt upon at some length, while its electrical theory is outlined. The results of numerous tests on the new cells are given. All of the tests show that the cells are remarkably immune from deleterious effects due to careless treatment. Cells have been allowed to dry out, have been permanently short-circuited, or even charged in the wrong direction. These cells have shown a full restoration of their capacity after a prolonged restoring normal charge. In its large output at heavy discharge rates, its low depreciation in capacity and its durability under severe adverse treatment, the cell approaches the capabilities of a piece of mechanical apparatus more nearly than is ordinarily credited to electrolytic structures. For this reason it is specially adapted to automobile service, where the treatment is abnormally arduous and severe.

In the discussion which followed, Prof. Burgess gave the results of some tests made by two of his students in his laboratory; he called attention to the fact that, in some cases, gas is liberated during the discharge. Dr. A. E. Kennelly pointed out that in this cell an approach has been made to the steel structure in dynamo construction, with respect to the number of watts per pound. The efficiency of the cell is low, but the cell is fool-proof and will stand the worst treatment.

Dr. J. W. Richards (Lehigh University) then presented his paper on "Electrolytic Conduction." In the discussion Messrs. Hering, Roeber, Patten, Bancroft and Kahlenberg participated and pointed out that the one experiment given by Dr. Richards as support of his theory would not be sufficient proof.

Prof. R. Lorenz's (Institute of Technology, Zurich, Switzerland) paper on the "Electrolysis of Fused Salts" was then read in abstract by Dr. E. E. Roeber.

The final paper of Thursday's session was Prof. W. Ostwald's (University of Leipzig, Germany) paper on "Electrolysis and Catalysis." In the absence of the author, it was read in abstract by Prof. W. D. Bancroft.

The Thursday session finished the work of Section C of the Congress, and the Friday session was, in fact, an independent meeting of the American Electrochemical Society, to which, however, the members of the German Bunsen Society and the British Faraday Society, as well as members of the

International Electrical Congress, had been invited.

At the opening of the session Dr. Hans Goldschmidt (Essen-Ruhr, Germany) presented the good wishes of the German Bunsen Society to the meeting, and Dr. J. W. Richards spoke for the British Faraday Society. The first paper of Friday's session was presented by Dr. H. E. Patten (University of Wisconsin) on "An Analytical Study of the Deposition of Aluminum from Ethyl Bromide Solutions." The paper was chiefly of chemical interest.

Prof. W. D. Bancroft (Cornell University) then read a paper on "The Aluminum Rectifier." He has used phosphoric acid as electrolyte. When the current is gradually increased, the current efficiency starts very low, about 50 per cent, and is later on pretty nearly constant, about 75 or 80 per cent. The power factor starts with 35 per cent and goes up to 90 per cent, with increasing current. The voltage efficiency is low, going down to 30 per cent.

In the discussion of this paper, Prof. Burgess referred to his investigation in which he attempted to give an analysis of the losses in the rectifier. Prof. Bancroft expressed the belief that Burgess' valve theory is not the correct explanation; he considers the valves as a source of inefficiency of the film, while Burgess believes that the whole current passes through these perforations.

Mr. W. McA. Johnson (La Harpe, Kansas) then presented a paper on "Some Aspects of Applied Electrochemistry," which was not discussed.

A paper by Mr. F. A. J. FitzGerald (Niagara Falls, N. Y.) on "The Use of Carbon for the Study of the Temperature in the Electric Furnace" was then presented. In the absence of the author it was read by Dr. J. W. Richards. The method is based on the fact that if a piece of amorphous carbon is subjected to different temperatures it changes its physical and chemical properties.

The last paper of the session was presented by Prof. W. D. Bancroft (Cornell University) on "Electrolytic Separation of Cobalt and Nickel." The method described is chiefly of chemical interest and is useful for the preparation of pure cobalt and nickel salts, although it requires considerable time.

Prof. Burgess then proposed a vote of thanks to the Organization Committee of International Electrical Congress and the meeting adjourned.

SECTION D.

The proceedings of Section D opened Monday morning with Chairman Charles F. Scott in the chair. A paper by Sig. E. Bignami on "Electrical Transmission Plants in Switzerland" was read in abstract by the secretary, Dr. Louis Bell. This paper was mainly of a statistical nature. It would appear that Swiss practice is not so uniform as in this country. The most usual frequency is 50 and there are a number of direct-current transmissions.

Chairman Scott, in opening the discussion, remarked on the large number of such installations in a comparatively small country. Dr. F. A. C. Perrine commented on the high-load factor in the Swiss plants, most of which had a load factor of over 50 per cent. This showed good management and attention to details.

Chairman C. F. Scott then announced that he had hoped to have prepared for this congress a history of long-distance power transmission in California. Since his arrangements for such a paper had failed he had himself prepared a short history of the first transmission work in this country, which he read.

The session on Tuesday was opened by the reading of a paper by Mr. J. S. Peck, on "The High-Tension Transformer in Long-Distance Power Transmission." He pointed out what an important element the transformer is in long-distance transmission and what great improvements there must have been in transformer construction in ten years when it is considered that in 1893 so little was known of insulating materials that a transformer wound for 10,000 volts involved great hazard. Now 60,000-volt transformers could be built with certainty that they would be a success. Transformers could be divided into three general classes: (1) Air blast. (2) Oil insulated, air cooled. (3) Oil insulated and water cooled. Another class sometimes used was cooled by circulating the insulating oil through cooling coils outside of the transformer. The fire risk with oil-insulated transformers had been much discussed lately. He did not consider there was much risk because the oil used was not combustible except at high temperatures. It was now common to put a very tight case on transformers to reduce the fire risk. He presented curves showing the increase in manufactured output of transformers from 1892 to 1903; also curves showing the increase in maximum and average capacity of transformers manufactured each year, and the increase in maximum and average voltages. The latter had increased from an average of 3000 volts and a maximum of 10,000 volts in 1893, to an average of 20,000 volts and a maximum of 60,000 volts in 1903. He also gave curves showing the principal characteristics of modern transformers.

Mr. F. O. Blackwell, in discussing the paper, did not agree with Mr. Peck about fire risks. He thought the storage of a large amount of oil in transformer cases was analogous to the storage of a lot of lubricating oil, for example, and as much care should be taken to isolate the oil-insulated transformers as the supply of lubricating oil for a power station. He recommended the building of a station with fireproof and airtight compartments for the transformers. Such compartments could be compared with the varnish tank compartments used in a certain factory for containing the varnish vats used for dipping coils. In case a vat took fire it had been demonstrated that it was only necessary to close the compartment and the supply of air being soon exhausted the fire would go out. He called attention to the great saving in first cost by sacrificing a little in efficiency. A transformer of 96 per cent efficiency could be obtained at about one-half the cost of the same capacity with 99 per cent efficiency.

A discussion started by Mr. E. Kilburn Scott as to whether cooling ribs both inside and outside of a transformer case would not increase the radiating ability, brought out the fact that such ribs were of no value on the inside, as the heat would pass from the oil to the metal much more rapidly than from the metal to the air. Dr. Bell said that while it was quite possible to enclose transformers completely in fireproof compartments, it was at the expense of simplicity. Much trouble might be avoided by not trying to make a station too compact. Plenty of room in a station or what might even be called waste space was frequently one of the best forms of insurance that could be carried.

Some questions were raised about securing of good oil, especially in England. Mr. Walters, of the latter country, said the only way to be sure of good oil was to purify it yourself. His company dried out the moisture by heating the oil with steam coils in a case and afterward filtering to take out impurities.

Mr. F. O. Blackwell cited a recent case where an oil did not have anywhere near the dielectric strength that it had at the factory. It was brought back to standard by pumping hot air through it. The trouble was with the barrels, which were not perfectly dry before the oil was put into them for shipment.

Mr. J. S. Peck said that transformer oil must be mineral oil bought under rigid specifications as to freedom from moisture, acids or alkalies. Oil in transit may absorb moisture.

Professor Harold B. Smith read his paper entitled "Notes on Experiments with Transformers for Very High Potentials." This was followed by Mr. F. G. Baum's paper on

High Potential, Long-Distance Transmission and Control.

After giving the equations for determining the charging current for three-phase lines and the inductance pressure due to any chosen current, the author discusses the rise in pressure due to the charging current, assuming for this purpose that the actual condensance of the line is concentrated at the centre and that the leading current which it consumes is drawn through one-half of the total line inductance. In investigating the surges produced by opening a line under load or short circuit, a similar assumption is made as to the distribution of the reactances. It is shown that, due to the series connection of the line inductance and condensance, the energy stored in the magnetic field of the conductors under condition of excess current, when the terminal circuit is opened, must pass into the line condensance and later be discharged into the inductance, the surges thus produced assuming a frequency corresponding to the square root of the product of the self-induction and capacity of the line, as is well known. The rise in potential due to the surging current is as a first approximation independent of the length of the *line*

and equal to 200 times the interrupted current in amperes.

The author describes in detail the insulator selected for the greatest transmission system in existence, that of the California Gas & Electric Corporation, which operates 700 miles of 50,000-volt transmission circuits. In the construction of the pole line, iron pins are used on all new work, and towers are considered the ideal supporters for the wires, though but few are used at present. Advantage has been taken of hills and ravines to use long spans, 1000 to 1800 feet, of aluminum wires. The general practice is to generate at 2300 volts and step up to the line voltage, the primary of the transformer being connected star with grounded neutral.

The paper drew out a lengthy discussion and much praise because of the data it gave from practical experience with the immense California Gas & Electric Company's system with over 700 miles of line and potentials approaching 60,000 volts. In concluding his paper Mr. Baum emphasized his belief that very high voltages are best for lines of 50 miles in length and are to be chosen in preference to low voltages because experience had shown them to be more free from trouble. Lightning troubles the highest voltage lines the least, and the rise in voltage caused by surging upon breaking a short circuit would be less, with the higher voltages by the formula he derived in the paper, which gave this rise in voltage as 200 times the interrupted current. The higher the voltage the less this current, therefore the less the voltage rise.

In response to questions Mr. Baum stated that the air gap on the horn type lightning arresters on a 60,000-volt line is about 4 or 4½ inches between each leg and ground, one such gap being used. A line at 50,000 volts was operated through the city of Oakland. A lengthy controversy arose over the usefulness of the horn type lightning arrester.

Dr. Perrine said the point of the paper was not lightning arresters. The important point was that we had here a great system which was free from the majority of the minor difficulties usually discussed. The use of very high voltage with small current almost wiped out the dangers of surging upon opening short circuits. In the paper no mention was made of artificial regulating drives for compensating for leading currents due to capacity or lagging currents due to induction, because with a system fed at many points and supplying current at many points as in this case, such difficulties disappear. Thus the very complexity of the system is the secret of its successful operation.

Dr. Bell agreed with this, but pointed out that the ordinary transmission was not of this class. Mr. Baum, illustrating the flexibility of his company's system, showed how, on one occasion, when the hydraulic plant at one of the power houses was being repaired, power was transmitted 350 miles, and the disabled power house being near the end of this line a generator was started as a synchronous motor to supply lagging current to counteract the condenser effect of the long line.

Mr. M. H. Gerry, Jr. thought the limiting factors of high potentials would be the accessory apparatus, such as switches, lightning arresters, etc. Mr. Baum disagreed with Mr. Gerry, as he was ready to build switches for 100,000 volts, and thought arresters would give less trouble at that voltage than at present. The line insulators limited the voltage.

Dr. F. A. C. Perrine read his paper on

American Practice in High-Tension Line Construction and Operation,

explaining in introduction that it was written with the idea of summing up American practice for the benefit of foreign members of the Congress.

In the choice of voltage it is considered best practice to use 1000 volts per mile, provided the length of transmission be not above 60 miles, since above 60,000 volts no commercial work has been regularly operated. Where direct generation at 6600 or 12,000 volts has not been resorted to, the practice is tending to the use of 2300 volts. The 2300-volt oil switch is both better and cheaper than any 500-volt switch on the market. For plants operated at less than 25,000 volts the step-up transformers are either the water-cooled, oil-filled or the air-blast type. Oil switches with either horizontal or vertical break are the standard today, no preference being given to the horizontal switch, though the author believes that in the future this type will be used as a standard for the highest potentials. For transmission at less than 25,000 volts, the delta connection of transformers is preferable; above this value star connection should be used. As regards conductor materials, the only ones at present available are copper and aluminum, preference between them being almost entirely a matter of price of transmission lines. For voltages above 25,000 no thoroughly satisfactory lightning arrester has been presented.

Thursday morning's session opened with a paper by H. W. Fisher on "Sparking Distances." This paper gave the results of extended researches by the author on the sparking distances between sharp points corresponding to different voltages. One of his efforts was to determine the methods of arranging points which would give the most uniform results. He used concave discs a short distance back of the points. He found that the sharpest points would not give the minimum sparking distance, but that points having a diameter of .003 inch would give this.

After the reading of the paper, in response to a question from Dr. Bell, the author stated that the use of ordinary commercial needles just as they come from the package is likely to introduce variation or errors of 2 to 3 per cent. C. E. Skinner spoke of the sparking method of determining very high voltages, having been formerly used in connection with insulation tests, but having been abandoned because of the errors likely to creep in.

H. W. Buck then read his paper on "Aluminum as An Electrical Conductor." He enumerated the legitimate uses of aluminum in electrical work for appliances such as bus bars, high-tension line conductors and low-tension feeders not requiring insulating covering. On account of its large cross section for a given conductivity, it is not suited to interior wiring or locations where an insulation covering is required. Aluminum is difficult to solder, probably because it is always covered with a thin film of oxide. But aluminum has now reached the place where its use is no longer an experiment. The early troubles from breaking at unexpected places have been overcome in the present stranded conductor. It is durable except when exposed to sea fog and in the neighborhood of chemical fumes, and the wire can be given a weatherproof covering when such districts are passed through. The trouble from sleet seems to be less with aluminum than with copper conductors. It costs less to transport and string than copper because it is lighter. When stringing in rough country, however, more care is necessary than with copper to avoid abrasion of the soft aluminum conductors. Soldering aluminum joints has not been found necessary.

The paper of F. O. Blackwell on

"Conductors for Long Spans"

was then read by Paul M. Lincoln, so that both the Buck and Blackwell papers could be discussed together.

The calculation of long spans is primarily a suspension bridge problem in which all of the mechanical stresses must be fully investigated. The strength of the conductor is at least as important as its conductivity, and the purpose of the paper is to give the results of investigations made by the author to determine the characteristics of conductors so as to secure some definite basis upon which to figure long spans. The available materials, copper, aluminum, iron and steel, are described from an experimental standpoint, numerous test data being given. Equations for determining the design of long spans are included, the constants depending upon the physical characteristics of the material being taken from the results of the exhaustive tests made by the author.

P. N. Nunn, in discussion, questioned whether in actual practice the deflection of aluminum spans under highest temperatures is more than copper. Aluminum conductors are most apt to be broken by arcs. In the five years' experience that the Telluride Power Transmission Company had had with aluminum on lines in Utah and Montana, he remembered but one break not due to an arc. C. W. Hutton said that in crossing valleys the California Gas & Electric Company had been trying long spans. There was one 1800-foot span of aluminum cable. There was no trouble from crossing of wires in the wind, as all conductors would swing in unison.

V. G. Converse presented a paper on "High Tension Insulators." He gave drawings and brief descriptions of the principal highest voltage insulators from 1893 to 1904. Some of the latter for 60,000 volts were 14 inches in diameter and weighed 25 pounds. Possibly the insulator of the future for higher potentials and long spans would weigh several hundred pounds. He outlined the tests which should be applied to insulators.

Chairman Scott, in discussion, said that some of the latest insulators might seem rather formidable as to size and cost, but after all the insulators are likely to be a very small item in cost of plant. One case figured on recently showed that the cost per kilowatt of plant capacity for insulators was such that fixed charges on insulator investment were only 2 cents per kilowatt capacity per year.

"High-Tension Transmission Lines" was the subject of a paper by M. H. Gerry, Jr. which was then read. Mr. Gerry at the close of his paper spoke of the discussion that had been going on regarding the relative merits of iron and wood pins. He thought there was no room for argument. The wooden pins were better because they had the practical effect, if they were properly treated, of adding that much extra insulating material in the center of the insulator and increasing the thickness of the dielectric. Of course, that part of the pin which was exposed to rain was of no value as an insulator, but the end of the pin had a value in virtually increasing the thickness of the insulator just under the wires that should not be lost sight of. He thought the burning of pins was due to a too thin dielectric at the head of the pin. Mr. Converse agreed with him on the latter point. Chairman Scott said Mr. Gerry held the record of being the first to operate at over 50,00 volts, having started such a line two and a half years ago, and that his experience was therefore of value. Dr. Perrine described an insulator something like a Chinese pagoda, which he thought designed on theoretically correct lines, which had several petticoats, each petticoat being curved outwardly so that all parts of its surface in a given plane were equally distant from the edge of the petticoat next above. This gave no one point of much higher potential stress than any other. Dr. Bell criticised some of the recent attempts to build insulators of enormous size. It was out of the question to secure good porcelain in such enormous tubs. Mr. Hutton then told of trouble with the umbrella type of insulator by the collection of salt dust from fog.

Friday morning Section D took up the paper by J. F. Kelly and A. C. Bunker on

"Some Difficulties in High-Tension Transmission and Methods of Mitigating Them."

The authors treat of pressure of over 30,000 volts and lines exceeding 50 miles in length. The greatest value of electrical tests is to determine before being used whether the various parts are homogeneous and whether they have been properly cemented together. The locality through which the line passes and the design of the insulator will determine what factor of safety must be used. Trouble from the charring of the wooden pins due to the continued leakage of current over dust-coated insulators may be corrected by placing a metal short-circuit around the pin or by the use of a metal pin. Poles should be treated to prevent decay. Every second or third season the earth should be dug away from the pole for about 18 inches below the ground line and the surface exposed should be freed from decay and be treated. The cost varies from 60 cents to $1.00 per pole. The large number of fatal accidents which have been occasioned by the telephone lines coming in contact with the power wires would warrant a separate pole line even if the series were no better. The fact that a telephone is seldom of service in times of line disturbance points to the desirability of separate pole lines.

The general subject of this and the Gerry paper being open for discussion, Mr. Bunker took exception to Mr. Gerry's ideas on wooden pins. In some places he had had wooden pins rot or mold inside of six months. In other places they would last indefinitely. Dr. Bell pointed out that wooden pins are frequently not treated properly. It was not sufficient to treat them by simply boiling in paraffine. Putting them in vacuo would take the steam out of the pins and allow the paraffine compound to enter as no amount of boiling would. What Mr. Bunker called molding of the pin was really due to brush discharge. Mr. Bunker cited his experience with a 40,000-volt line exposed to salt and marsh winds where certain insulators on wooden pins were causing as high as 60 breakdowns per month. The substitution of iron pins for wooden ones under the same insulators reduced the trouble almost to nothing. P. N. Nunn appeared as the champion of the wooden pin and the all-wood line construction as well. Some people, he said, pointed to the insulators on his Provo line and said, "Of course wooden pins must be a success with such insulators"; others pointed to the wooden pins and said, "Of course such insulators would be a success with such long pins." Practical success was better than theories. He did not know that his Utah lines ever had burned a pin save where it and the insulator were covered with alkali dust. They had operated through a drizzle with as many as 50 cracked insulators on the line. Pins were treated by placing in hard paraffine at 150° C. from 6 to 12 hours. The important part was that the pins were kept below the surface of the paraffine as it cooled. The paraffine would then be sucked clear into the center of the pin, probably due to the condensation of the vapors in the pin. The heart of pins so treated will not absorb the slightest moisture after soaking, as far as can be determined by delicate chemical balances. He took the position that if the insulator is made good enough so that it can be safely placed on an iron pin, it is good enough so that there is no danger of its burning a wooden pin. Later in the discussion he expressed the opinion that ultimately we will probably come to iron pins and steel towers, but for pioneer work such as is being done now with insulators having only a small factor of safety, we need the help of the wooden pin. Answering a question as to whether men were ever killed from contact with wooden poles, Mr. Nunn said that if a pole had become charred the men had learned that it was wise to feel at the base of the pole first, gradually working up, to test the potential existing on the pole. E. Kilburn Scott told of the necessity of using iron base poles in India because of the habit of white ants starting below the ground and eating out the inside of wooden structures, leaving only the outside shell. A barb wire wound spirally around a pole is also sometimes necessary to keep the monkeys from climbing it.

A history of "The Work of the Telluride Power Company" was then read by P. N. Nunn, chief engineer of that company, who was introduced by Chairman Scott, making a few appropriate remarks about the pioneer work in high voltages done by this company for fourteen years, this being the first presentation of it before a technical society. Mr. Nunn's paper began with an account of the company's first 3000-volt, single-phase transmission in 1890, followed by experiments on three different kinds of circuits in 1895 carried on for some time at 30,000 to 60,000 volts, during which time in the dry season 10,000 to 40,000 volts were carried on telephone insulators for about three months. These experiments gave the data upon which the first 40,000-volt line was built at Provo. This line had 76 inches between wires and pins, bringing the insulators 6 to 12 inches above the crossarms. The burning of crossarms at iron braces caused the adoption of the all-wood construction on later lines. The company now has 1,000 lines of transmission line in Utah, Montana and Colorado, and some six power stations. Many interesting historical details were given in this paper that space does not permit to be mentioned here. At the request of Chairman Scott, Mr. Nunn added a few words about the provisions being made at the new Provo plant to train employees in high-voltage work and carry on researches on matters of value to the company.

The paper by L. M. Hancock on the "Bay Counties Transmission System," and the paper by R. F. Hayward, on "The Operation of Power Plants in Parallel," were read, and after a short discussion on the latter the section adjourned.

The paper which was to have been presented by R. D. Mershon on "The Maximum Distance to Which Power Can Be Economically Transmitted," was not ready for presentation, but was read by title.

SECTION E.

This section opened on Monday morning with the reading of an interesting paper on "Improvements in Electrolytic Meters," by Mr. Arthur Wright, the originator of the well-known Wright Demand meter system; in the absence of the author the paper was read by Mr. J. R. Dick. There was no discussion of the paper, and the section passed on to the reading of Mr. Etienne de Fodor's paper on

Rates for Electricity Supply.

The author reviews in detail the causes which have led to the prices placed upon electric current used for lighting and power purposes, competition with gas having been in most cases the controlling factor. In order to effect a proper introduction of the electric motor and make its advantages known, it was necessary for central stations to offer certain inducements in the form of cheap or reduced rates for power current. From a table giving the prices charged for electrical energy in fifty cities, it is shown that the normal unit price for power current is about one-third of that charged for light. Since no restrictions have been placed as to the time when such power should be used, the electric companies have failed to recognize the logical situation. Power users see no reason why they should not demand the same rates for light as they have for power, since the light they use is also for "industrial" purposes. The author proposes to establish a unit rate for light and power, the unit rate to be divided into two classes or steps, according to the time at which the energy is consumed. Unfavorable peak loads due to the simultaneous operation of motors and lamps in the evening can be obviated by such a double-tariff system when there is a great difference between the maximum and cheaper rate.

In the discussion which ensued, Mr. Gripper said that he did not agree with the author's idea of raising the rates for power service and lowering those for lighting to equality; he thought the proper result to strive for was the lowering of power rates to such a degree as to increase the service sufficiently to make the lighting load small in comparison with the power load; then it would not be so important to get high rates for lighting, and those rates could be lowered. Mr. Arthur Williams pointed out the fact that the difference between rates for lighting and those for power is due chiefly to the difference in load factors of these classes of service; the lighting load shows the familiar sharp peak, while an ordinary power load does not—the average load is a much greater percentage of the maximum than in the case of a lighting load. Col. Crompton agreed with Mr. Gripper and also agreed with the author that the introduction of a unit scale of rates for lighting and power service could be accomplished only by decreasing the rates for lighting current; the companies in England that charge the lowest rates, he said, pay the best dividends. The average rates there are 10 cents per kilowatt-hour for lighting and 5 cents for power current. Mr. Robt. Hammond advocated rates based on a high charge for the first hour and low price for succeeding hours; the rates in a certain London plant are 14 cents for the first hour for lighting current and 8 cents for power current; for all succeeding hours, 2 cents for each class of service. He thought that Mr. de Fodor overlooked the fact that the cost of producing current includes more than the mere expense for fuel, station employes, etc., which varies roughly with the output of the station; the cost of producing a kilowatt-hour was in many cases doubled by interest and other fixed changes. Mr. Louis Ferguson agreed with Mr. Hammond's remarks concerning cost of production and with Mr. Williams as to the effect of load factor upon rates; the power load factor is so much higher than that of the lighting service that a much lower rate is practical for a given number of kilowatt-hours. Mr. Torchio elaborated the argument based on differences in load factors, illustrating his remarks by diagrams which showed the general characteristics of lighting and power load curves. Mr. J. R. Dick pointed out that simplicity of tariff rates does not necessarily give the best results, although desirable so far as it may be practicable. An analysis of operating conditions and detail results is necessary for intelligent management. He thought it impracticable to have a single scale of rates for both lighting and power current.

The next paper presented was one by Mr. George N. Eastman, delegate from the National Electric Light Association, on the subject of

The Protection and Control of Large, High Tension Alternating-Current Distributing Systems.

The principal object to be attained in the installation of protective apparatus is continuity of service. The various elements which enter into the determination of the protection needed are treated individually. In an alternating-current system the condensance performs the function of elastic ligaments, connecting the system to ground. The effect of a ground on a system depends upon the nature of the ground and the value of its reactance in relation to the condenser reactance. It is shown that a ground connection on an underground system would cause considerable more trouble than on an equivalent overhead system. In order to eliminate the chances of obtaining excessive electrostatic disturbance on the system, the proper means to employ is the permanent grounding of the neutral of high-potential systems. Ground detectors, overload relays and oil circuit-breakers are discussed, and the importance of periodic inspection and tests of all protective apparatus is emphasized.

Mr. W. C. L. Eglin said that perhaps the trouble that central station engineers fear worst is interference in underground feeders connecting the station with a sub-station. These troubles should be located just as soon as they develop and, if possible, before they actually manifest themselves, when the cable is about to break down; from Mr. Eastman's paper, it seemed that this was the point to which he and his colleagues were devoting most of their attention. The general description, of course, applied to most central stations in this country, and he would like to hear how it compared with the practice in other countries. There was, however, no further discussion of the paper, and the section passed on to the reading of Mr. Eglin's paper on

Rotary Converters and Motor-Generator Sets.

The author discusses the differences in make-up, operation and efficiency of the rotary converter and motor-generator. He shows that the rotary from an operating standpoint early indicated that the machine had a higher inherent efficiency; that the voltage and load could be easily regulated and the power factor adjusted to suit the best operative conditions of the system, and that the first cost of the outfit was comparatively low. For these reasons it was extensively used, especially for frequencies of 25 cycles. He gives tables of comparative costs and all-day efficiencies under commercial conditions and concludes that the type of machine best suited for sub-stations depends principally upon the frequency of the system and the importance of reliable and continuous service. The frequency to be used depends upon other conditions which are outside the scope of the paper. In cases where the largest percentage of the output of the generating station is to be transformed to low-tension, direct-current, 25-cycle rotary converters should be installed on account of their higher efficiency and lower first cost. The very large number of these machines which are now in successful operation proves conclusively their reliability and effectiveness. In mixed systems, and where the percentage of current transformed for low-tension distribution is small, motor-generators are desirable. With higher frequency, particularly 60 cycles, it has been shown that motor-generators compare favorably in efficiency and are much more reliable and simple in their operation.

The paper was discussed briefly by Col. R. E. B. Crompton and Messrs. Philip Torchio, M. J. Tilney and W. C. L. Eglin; the discussion brought out the facts that in England a large system using motor-generators shows an over-all efficiency from generator to consumer of 70 per cent. to 75 per cent., that starting the motor-generators on the alternating-current side is accomplished with about 60 per cent. of the full-load running current, and that in this country the preferred practice is to start on the direct-current side, which requires only about 25 per cent. of the full-load running current.

The first paper read on Tuesday was Mr. Carl Rodenbourg's, on

The Prussian System of Electric Train Lighting.

A most interesting system for obtaining constancy of illumination nothwithstanding variation of supply e.m.f., and regulation for variation in speed of the generator without special devices, is described by the author. The principle of the constant e.m.f. at the lamps with a variable e.m.f. of the source of energy is attained by the insertion of very small iron wire in the circuit of each incandescent lamp. When such a wire is connected in series with the lamp, the e.m.f. at the supply terminals can be considerably increased without subjecting the lamp to an excessive current. If the current tends to increase, the temperature of the wire increases and its resistance is considerably increased, so that within wide limits of e.m.f. the current is kept fairly constant. With a certain adjustment of resistance and lamps, a variation of e.m.f. from 56 to 86 volts changed the current taken by the lamp from 8.0 to 8.7 amperes. No such extreme change of e.m.f. takes place at the storage batteries used in the train lighting, and the variation in the illumination of the cars is not perceptible to the eye under operating conditions.

A turbo-dynamo generating unit, consisting of a short dynamo driven at 2000 r.p.m. through a 10 to 1 reduction gear by means of a 20-h.p. De Laval steam turbine mounted on the boiler of the locomotive, has given excellent satisfaction in connection with storage batteries which act mainly as a reserve. In many instances it is found desirable to drive the generator from the car axle and not from a separate steam prime mover. In order to overcome the difficulties found with automatic low-current circuit-breakers used for interrupting the current if the speed of the dynamo falls below a certain limit, there has been substituted therefor an electrolytic rectifying cell.

The electrodes of the electrifying cell consist on one side of aluminum and on the other of iron which is not soluble in the electrolyte of the cell. This cell acts as a check valve in the train-lighting system, on account of the property of aluminum which causes the insulating film formed on its surface to interrupt a current even at several hundred volts if sent through the aluminum into the electrolyte in a positive direction, but allows the current to pass almost without diminution if the direction is reversed.

In order to provide for the generation of electricity in event of the dynamos being driven in the opposite direction, there is used an arrangement by means of which the commutator brushes are carried forward until a point is reached at which the dynamo generates e.m.f. in the same direction as before. By the use of four aluminum cells in the conversion of alternating into direct current, this mechanical arrangement can be avoided.

An arrangement is in preparation for prevention of the excessive charging of the storage battery at very high speeds. The dynamo, which in general is designed as a shunt machine, is to be provided with a series coil differentially connected, so that an increase in current weakens the field and lowers the generated e.m.f.

In the discussion of the paper, Col. Crompton said that the idea that the Pintsch system is dangerous dates back twenty-two years, and is without foundation; as a matter of fact, it is so safe and simple that it has been extremely difficult to get an electric lighting system to compete with it. He had come to the conclusion that the best way to provide electric lighting on trains is to use accumulators on each car, set into a compartment under the car, and replaced at occasional stations with fresh batteries; this dispensed with machinery, automatic switches and other complications. Prof. George F. Sever outlined briefly the two general classes of train lighting systems in use in this country: the one in which a dynamo is driven from the car axle and storage cells are employed in conjunction with it, to take care of fluctuations, stops, etc., and the other involving the use of a dynamo driven by a small engine and located in the baggage car, no batteries being used. The former, he stated, appeared to have preference.

The second paper was a superb discussion by Signor E. Jona, delegate of the Italian Electrotechnical Association, on

Insulating Materials in High-Tension Cables.

The paper contains so much mathematical treatment that an abstract is impracticable.

The author's conclusions were as follows: Every insulating material has a limit of resistance to puncture; when the maximum e.m.f. per unit of thickness is exceeded, increasing the thickness of the material will not prevent a breakdown. The stress is greatest nearest the conductor, so that adding insulating material on the outside does not reduce proportionately the stress on the inner layer; hence an enormous increase in thickness of insulation would be required in order to raise appreciably the breakdown point of the covering. In order to obtain the highest resistance to puncture, the insulating covering of cables should be applied in layers of graded specific inductive capacity, the material having the highest specific inductive capacity being next the conductor, and so on, to correspond to the potential stress gradient, which, as above stated, is greatest near the conductor.

Central Station Distribution Systems.

The subject of distribution systems for central stations was covered very fully by three papers which were read in the order named, and discussed jointly: "Distributing Systems from the Standpoint of Theory and Practice," by Mr. Philip Torchio; "The Direct-Current Distributing Systems of American Cities," by Mr. Alex. Dow, and "The Superiority of Alternating Current for the Supply of Current to Large Cities," by Dr. Gotthold Stern.

Mr. Torchio's paper will be printed in our next issue. Mr. Dow's paper presented a brief history of the development of the Edison stations in Boston, Buffalo, Chicago, Cleveland, Detroit, New York (Manhattan), Philadelphia and St. Louis and described the general practice in those plants. Dr. Stern's paper was a brave but unsuccessful effort to show that direct-current apparatus has no claims for central station work in large cities. His statements were not taken very seriously in the discussion of the three papers.

Mr. Townsend Wolcott stated that all the cable insulation he had tested runs over 1000 megohms per mile, with the cable immersed in water, so that the maximum leakage through such insulation under 1000 volts would amount to an ampere-hour in 1,000,000 hours, which would be equivalent to 100 years; Dr. Stern's fears concerning electrolysis in the covering of direct-current cables subjected to high voltages, therefore, seemed unfounded.

Referring to Mr. Torchio's paper, Col. Crompton said that the operating conditions in England were different from those in this country. The largest English stations have found it advisable to adopt high-voltage incandescent lamps (200-240 volts) and to double the old voltage of their distribution systems. The lamp makers had said it was impossible to produce efficient high-voltage lamps, but the insistent demand for them had caused them to be made; the high-voltage lamps were of as good efficiency as those for 110 volts and thereabouts. This condition practically wipes out a large part of Mr. Torchio's argument, so far as England is concerned, and transfers his No. 17 hypothetical equipment from the bottom of the list to the top. Most English systems are built on this basis, except that they use motor-generators instead of rotary converters; they are now just beginning to try converters, however, being encouraged by the reports of results obtained in America with them. Mr. Torchio's method of basing his argument on a hypothetical town was wrong; no such town existed as that which was assumed in the paper. He himself had prepared, at great expense, exhaustive estimates and figures based on an "ideal" town, but he had never got his money out of them. Col. Crompton also advocated strongly the use of storage batteries, and stated that responsible companies in England were putting out batteries on a guarantee ot 6 per cent. maintenance.

Mr. Robt. Hammond, who has spent a great deal of time during the past thirteen years analyzing central station records in England, where all records must be filed with the Government, said that he preferred either straight alternating or straight direct current throughout a plant; for distances of 2½ miles or under, he would install a direct-current plant of "double" voltage (440 to 480 volts across outside wires; three-wire); for greater distances, a straight alternating-current plant. Mr. Louis Ferguson disagreed with this policy; he thought by combining alternating-current transmission with direct-current distribution the full advantages of both systems were made available and their chief disadvantages avoided. Elevator motors, he said, referring particularly to Dr. Stern's advocacy of induction motors, must be direct-current for high car speeds; at 250 feet a minute or over, the induction motor was impossible.

Mr. Arthur Williams pointed out that lighting standards in England were not quite so high as here, which possibly accounts for the indifference to high-economy lamps. The American central stations take the ground that they sell *light* as distinguished from selling merely current, and it is not expedient to allow customers to purchase their own lamps unrestricted. Mr. Torchio, closing the discussion, said that the conditions described in his paper are not "ideal," but are to be found in most American cities of smaller size; his method, therefore, was correctly founded from the practical viewpoint. Referring to high-voltage lamp efficiency, he said that four or five years ago such lamps in England ran as high as 7 watts per candle, and he thought Col. Crompton must have in mind 3.5 watt lamps in saying that high-voltage lamps were now as efficient as those for the ordinary voltages.

The final paper of the day's session was Mr. Louis A. Ferguson's, on

Underground Construction,

which the author read in abstract.

Electric companies in the United States are practically committed to the drawing-in system of cables and conduit, and it is to such a system that this paper refers particularly. What is commonly known as the Edison "tube system" has been in the past used extensively for low-tension work, and it is still used to a limited extent, but on account of the relatively short life of the tube and the higher cost of repairs, its use in late years has greatly diminished. The principal advancement during the past ten years has been in the more general use of paper insulated cable as compared with rubber, the manufacture and installation of cables for extremely high voltages, the doing away with wood pump log and other inflammable material for conduit work, and a more stable character of construction in general. The next ten years will probably see underground cables worked at much higher voltages than those now used, possibly different material used for insulation purposes, and better methods of protecting underground cables.

The paper was discussed by Messrs. Arthur Williams, Taite, Crompton and Ferguson. Col. Crompton thought the method of making connection between overhead and underground lines which was described in the paper was inadequate. In Calcutta he had had great trouble from inductive discharges of a surging character at this point and had found it advisable to provide substantial hollow pillars to contain the connector tablets, and to furnish arresters and hand switches between the overhead and underground circuits. In London, he had had to provide much better ventilation at manholes than was described in the paper, in order to guard against accidents due to gases. He said that in certain parts of his company's system of distribution he used bare strap copper conductors, mounted on porcelain insulators, the latter being located in manholes at short intervals. The conductors were insulated from the duct walls only by air. In 17 years the maintenance had averaged only one-third of 1 per cent.

There was no session of this section on Wednesday, this being "Electricity Day,' 'on which the annual convention of the American Institute of Electrical Engineers was held at Festival Hall, in the Exposition grounds. At this convention, a paper was read by Col. Crompton on "Standardization of Dynamo Electric Machinery," which paper was discussed at Thursday's session of Sections B and E jointly. The first paper taken up Thursday was one by Prof. Clarence Feldmann and Mr. Josef Herzog on

The Distribution of Voltage and Current in Closed Conducting Networks.

The authors assume first the single case of current being supplied to a single receiver over power lines from two points at separate difference of potential·and show that the final current distribution may be regarded as the superposition of the partial distributions, one with load and equal potentials, the other with no load and the assumed unequal potentials. This same principle of superposition may be applied in whole net-works if different voltage or current consuming devices be applied successively. For studying net-works the authors resort to the method of transformation of the net-work or other parts in such a manner that the current and voltage distribution in the rest of the net-work remains unaltered. In most of the practical cases the net-work may be split up into such parts as by themselves may be completely treated by the method of transfiguration.

The paper was discussed briefly by Messrs. Lieb, Crompton, Kennelly and Junkersfeld. Messrs. Lieb and Crompton said that their respective companies had started out with the plan of laying out a model of the distributing system and carefully computing the distribution of the load on the mains, and therefrom, the size of the mains, but this had been later found unnecessary. The better plan is to lay down uniform standard-sized mains with a view to the probable increase in load in the immediate future, and to start with feeders sufficient to supply the mains, adding feeders according to the distribution of the load that developed in actual practice; in this policy Mr. Junkersfeld concurred. Dr. Kennelly said that the paper conferred the advantage of simplifying the calculation of mains and supplied a physical means of working out a mathematical problem.

The Electric Arc

was the title of the next paper, which was read by Dr. Charles P. Steinmetz. In it, the author presented briefly the characteristics of arcs between different kinds of electrodes and described some extremely interesting investigations of the mercury arc stream and the magnetite or flaming arc which had been carried on in the General Electric Company's laboratory. The familiar arc between carbon electrodes is not a typical electric arc; carbon has been used so largely probably because of its ready volatilization and the fact that it is the only material that will maintain an alternating-current arc at a relatively low difference of potential. The typical arc in air is that between iron and copper or their conducting oxides; the typical vacuum arc is the mercury arc stream. Magnetite electrodes and the mercury arc stream both act as rectifiers under ordinary conditions. In order to produce a true alternating-current arc stream in mercury vapor, 9000 volts are required; at lower voltages, every other half wave is suppressed, the current being unidirectional. The range of rectification is that between the direct-current e.m.f. that will maintain the stream or arc and the alternating e.m.f. that will strike across the gap when no arc exists.

In the absence of the author, Dr. Louis Bell read a paper by Prof. A. Blondel on

Impregnated Arc Lamp Carbons.

in which the author reviewed the development of the Nernst lamp and the mercury arc and led up to the different classes of electric arcs, the characteristics of which he described. He discussed at some length the investigations that had been made with mixed electrodes—carbon combined with various salts—and summed up the salient characteristics of arcs between electrodes of mineralized carbon, hollow and cored carbon, and his own form of electrode consisting of mineralized carbon within a thin sheath of pure carbon. The following table of comparisons was given:

Kind of arc.	Watts.	Mean hemispherical candle-power.
Ordinary open arc between carbons....	495	700
Enclosed arc between carbons	768	329
Steinmetz's magnetite arc	385	400
Bremer arc, inclined carbons; 9 amp...	495	4814
Blondel carbons; 9 amperes	500	4800

In the discussion of Dr. Blondel's paper, Mr. Lieb mentioned trials of the Blondel lamp in comparison with enclosed arcs, in which a 200-watt 3-ampere Blondel lamp showed better diffusion and effective illumination than a 500-watt enclosed-arc lamp using the usual type of carbon electrodes. Dr. J. P. Jackson said that an equipment of magnetite arcs in Harrisburg showed equal illumination with 9.6-ampere open arcs at distance 20 per cent. to 30 per cent farther away from the lamp; the magnetite lamps take 320 watts. Prof. E. L. Nichols said that comparison between artificial illuminants of the types now being developed was impossible by means of ordinary photometry on account of the selective radiation involved, and said that some other means of comparison must be devised before the relative merits could be determined. Dr. Steinmetz pointed out that high efficiency alone is not the commercial criterion; long life of electrodes and other operative conditions modified the matter very greatly. The titanium arc shows the highest efficiency of any, requiring about 0.15 watt per candle, but it does not meet commercial requirements.

Section E then joined Section B in the discussion of Col. Crompton's paper on standardization. The old question of frequency was the chief topic, the English standard proposed by Col. Crompton being 50 cycles, while the American standard of that order of magnitude is 60 cycles. The consensus of opinion was to the effect that there is too large an amount of 60-cycle apparatus in use to permit changing to 50 cycles in America; that as there were several frequencies in use in Europe it would perhaps be possible to get 60 cycles adopted there, but that the matter is chiefly one of commercial importance, so that engineering conclusions would have little weight. Profs. Steinmetz, Ascoli and Crocker, Col. Crompton and Messrs. Lieb, Scott, Gray (president British Institute) and Glazebrook participated in the discussion. Prof. L. Lombardi then read his paper on "Stroboscopic Observations of the Arc," which it is impracticable to abstract on account of the large number of photographs used to illustrate, and necessary to an understanding of, the paper; these were not available for reproduction. In discussing the paper, Dr. Steinmetz said that the observations of Prof. Lombardi bore out completely his own deductions from investigations recently made. He also pointed out that the mercury arc stream acts as a rectifier of alternating current between 6000 and 9000 volts, even with symmetrical electrodes; the direction of the rectified current is purely accidental, he said, depending on which half wave the arc stream happened to start with, but after starting, it maintained the current absolutely unidirectional.

Prof. E. L. Nichols' paper on "Standards of Light" was read by title. There was no discussion of it.

Friday's session opened with the reading of a paper by Mr. Gerhard Goettling, delegate of the Association of Edison Illuminating Companies, on the subject of

Storage Batteries as an Adjunct to Central Station Equipment.

The paper gives an outline of the present methods of installation and operation of storage batteries as practiced by the Edison Companies in the United States. The battery plates, as now furnished, show great improvements over those of previous years. The positive consists of a rigid conducting support, holding in place soft lead buttons of coiled ribbon with corrugated surfaces, these buttons extending slightly beyond the surface of the grid. The negative plate now consists of a hard metal supporting grid in which the various sections of active material are securely held in place by means of a thin covering of perforated lead. An important development is the substitution of thin wooden diaphragms between the plates as separators in place of the glass tubes heretofore generally used. This new separator effectively prevents any possibility of short circuits forming between the plates, thus keeping the cells in uniform condition, and resulting in a very considerable increase in the life of the plates.

The paper was discussed briefly by Messrs. Crompton, Lieb, Hammond, Junkersfeld, Tilney and Goettling. Col. Crompton pointed out that the life of a battery was determined by the life of the end-cells, and thought that on that account regulation by means of a reversible booster was preferable to the use of end-cell switches; he described in some detail the arrangement made in England for guaranteeing battery maintenance to stations purchasing batteries.

Mr. Lieb said that with the modern system of alternating-current generators, high-tension transmission and converting sub-stations, batteries are indispensable as auxiliaries in order to insure absolutely continuous service. Mr. Hammond explained that the maintenance contracts in England covered the care of tanks, plates and everything else, except the flooring under the batteries.

In the absence of the author, Mr. Henry Noel Potter's paper on

Nernst Lamps

was read by Mr. Percy M. Thomas. The author reviewed the development of the Nernst lamp in Europe and this country, and pointed out the differences between the European and American practices. He also briefly explained the characteristics of Nernst lamp glowers, ballast resistances and heaters, and described in detail the present American practice in the construction of these lamps.

The discussion of the paper, which was participated in by Messrs. Jorge Newbery, R. Hammond, George Wilkinson, A. C. F. Webb and Arthur Williams, did not bring out any unfamiliar points.

Steam Turbines.

A group of three papers was then read, one by Mr. W. L. R. Emmet, on "The Effect of Steam Turbines on Central Station Practice"; one by Professor Rateau, entitled "Notes on Steam Turbines Operating with Fall of Velocity," and one by Mr. Francis Hodgkinson on "Steam Turbine Performance."

Mr. Emmet in his paper presented the usual arguments in favor of the steam turbine, and also suggested that there was an excellent field for this apparatus in the use of exhaust steam from reciprocating engines, and also in operating on steam of low pressure obtained by delivering the jacket-water of gas engines to a boiler, and heating by means of the exhaust gases from the engines. The output of a reciprocating engine plant, he claimed, could probably be increased as much as 30 per cent. by the introduction of low pressure turbines with proper condensing facilities, and without any increase of fuel consumption or change in the boiler plant; used in conjunction with gas engines in the manner stated he thought that a similar increase in the output of the plant could be attained.

Professor Rateau's paper consisted of a mathematical analysis of different types of steam turbines, in the course of which he drew comparisons between turbines operating with a fall of steam velocity and those operating with drop of steam pressure. The former type, he said, could be designed to give low speeds, and would therefore be highly advantageous, but they were too uneconomical, showing 28 per cent to 44 per cent. lower economy than turbines of the multicellular type operating with drop of pressure. His paper contained a diagram plotted by means of formulas given in the paper, and showing that the drop of velocity type gave a maximum efficiency with the bucket speed about 30 per cent. of the steam velocity, while the multicellular drop in pressure type increases in efficiency as the ratio of bucket speed to steam velocity increases. The relation between the efficiencies of the two types, as shown by his diagram, is as 65 to about 74 at the speed ratio corresponding to the maximum efficiency of the drop in velocity type.

Mr. Hodgkinson's paper consisted chiefly of tabulated results of a large number of tests of recently built Westinghouse-Parsons turbines, most of which were also given graphically by means of diagrams. The author explained briefly the general principle of the Westinghouse-Parsons type of turbine, in the course of which he brought out the point that three barrel diameters were used merely for mechanical convenience; if only one diameter were used, the vanes nearest the steam inlet would have to be unmechanically small, or else those through which the steam passed last before exhausting would have to be unmanageably large. He also stated that each inch of vacuum beyond 25 inches will increase the economy of the Westinghouse-Parsons type of turbine by about 3 per cent. to 5 per cent.

Integrating Meters.

A paper by Mr. Caryl D. Haskins on "A Study of Integrating Electric Meters" and one by Mr. George R. Green on "American Meter Practice" were next read and discussed jointly. Mr. Haskins' paper consisted of brief descriptions of the various types of meters, namely, electrolytic, thermal, clock, relay, variable transmission and electrodynamic, the last-named class including, of course, the well-known motor type of meter. Mr. Green's paper was restricted to the consideration of the commutator and induction types of motor meters, and contained practical suggestions as to the proper selection, installation and care of meters, together with remarks concerning meter reading and tests.

In the discussion of the two papers, Mr. Dick said that in England the ampere-hour meter was used very generally, and was considered as good as the watt-hour type because the voltage fluctuations compensated each other, so that the average voltage was practically equal to the rated voltage of the circuit. He strongly favored the electrolytic type of meter, chiefly because of its simplicity and accuracy at all loads. Mr. Eglin pointed out that the ampere-hour meter even on direct-current circuits is not strictly accurate, on account of voltage variations, and it was grossly inaccurate on inductive alternating-current loads for obvious reasons. He said that in direct-current work, a practical objection to the electrolytic meter was that the customer could not read his meter; this was one of the strong reasons for discontinuing the use of the old Edison chemical meter.

A paper by Mr. Poulsen on "Producing Continuous Electrical Oscillations" and one by Mr. Horace F. Parshall on "The Yorkshire and Lancashire Electric Power Companies" were read by title.

The sections combined on Saturday, September 17, in general session at Congress Hall, Exposition grounds, where the closing exercises of the Congress were held.

SECTION F.

The first paper presented on Monday was that of Philip Dawson, entitled "Electric Traction on British Railways." Mr. Dawson sketched the conditions of electric traction in Great Britain and pointed out that electricity is the only hope there of suburban and short distance interurban systems.

In the discussion of Mr. Dawson's paper, Mr. H. Ward Leonard said that the important advantage of electricity over steam traction is that it will give maximum ton miles per mile of track. He did not consider that too much stress should be laid on comparisons with steam roads on the cost of wages or cost of fuel, and cited the case of the Pennsylvania Railroad, where both of these items during the past year have very largely increased, while the cost per ton mile has been reduced from 1.6 cents per ton mile to .36 cent. Mr. Sprague said that it should not be forgotten that the great success of the electric railway thus far has been in services requiring frequent stoppage. In applying electric traction to steam lines the primary consideration is the density of traffic, and he considered that so long as it was a question of sending out high power units at long and irregular intervals over great distances we might as well be frank and say that this is not a field for electric transportation. He considered that there were many other questions to be taken up and considered before that of the operation of trunk railroads by electricity.

The final paper of the session was that of J. B. Entz, on "Storage Batteries," which treated of the application of batteries to railway service. It was pointed out that economies may be achieved in the use of batteries at power stations through the improvement of the load factors of both the generating and transforming apparatus; their use would also reduce the capacity of machinery required for carrying the peak load. It is estimated that the total gain from the use of batteries may be 15 to 20 per cent. The author also discussed the subject of boosters in considerable detail and concluded his paper by the presentation of the details of the proper construction of a battery for railway service. He considered that the positive plates should be of the Planté type and the negative plates of the pasted type. In the discussion Mr. Sprague said that he favored very strongly the use of storage batteries in the New York Central electric system, particularly to reduce the size of sub-station equipment and partly to provide a reserve. Mr. J. S. Edstrom, of Sweden, said that in Europe, where the railway plants are much smaller than in this country, storage batteries are considered a great advantage, and this is particularly true of lines running but a few cars. In Europe batteries are guaranteed that at the end of ten years they will have the same capacity as when installed. Mr. Sprague said that the great size of some of our railway electric systems gave rise to conditions quite different than in Europe and rendered it inadvisable to use storage batteries in main power stations, though they would be advantageous in sub-stations.

Section F held a joint meeting on Tuesday with Section B, the proceedings of which are reported under that section. The proceedings of the joint session of the American and British Electrical Engineers will be found elsewhere in this issue.

On Friday four papers were read in abstract. The first was a paper entitled "The Mono Rail," by F. P. Behr, which was also presented before an audience in the Westinghouse Auditorium in the World's Fair Electricity Building. Mr. Behr built the first railway of this type in Algiers in 1883 and the second in London in 1886. A mono-rail system was constructed between Listowell and Ballybunion, in Ireland, and a high-speed mono-rail road is now being constructed between Manchester and Liverpool, a distance of 31½ miles. A speed is reached of 110 miles an hour, and each train consists of one car carrying from 40 to 85 passengers. The second paper, by Dr. Rasch, on "The Railway Booster," treated the subject largely from a mathematical standpoint. A paper by F. J. Sprague, on "The History of the Electric Railway," gives an account of the development of electric traction from the day of Davidson up to the present time and enters quite fully into the details of the multiple unit system. Mr. L. B. Stillwell, in a paper entitled 'The Wilkesbarre & Hazelton Railway," gives an account in detail of this railway, which is the first equipped in this country with the protected third rail.

At the opening of the session on Friday Dr. Louis Duncan read an abstract of his paper on the general subject of the application of electricity to railroads. He sketched the manner in which electric traction had displaced the horse railway and won its way for elevated and interurban service. In the heavier electric traffic the success has been due to the fact that the load factor in the generating station, where the losses are greatest, has been brought to a reasonable figure, the load factor at the sub-stations not being so important. Dr. Duncan considered that we can offer very little to trunk railroads with respect to decreased expense and increased facilities of operation, and that we are not in position to offer for general railroad work any particular advantage for electricity over steam. There are, of course, special cases in which electricity has tremendous advantages. Mr. Sprague considers that there is an absolute bar toward any system of electrical operation which requires more than one conductor overhead. He thought that if experiments demonstrated anything it was the impracticability of running trunk lines on the polyphase system. He considered that the single-phase motor had objectionable features, and that the direct-current motor, with respect to weight, efficiency, simplicity, reliability and perfection, is superior to the alternating-current series motor. Mr. Lamme contested Mr. Sprague's statement as to the superiority of the direct-current motor, and said that the alternating-current motor admits of the use of more current voltage in its windings, thereby eliminating troubles to which the direct-current motor is subjected. He did not anticipate any particular difficulty in applying the alternating-current motor to railroad work, and did not apprehend any danger from higher trolley voltage since it could not have any effect beyond the frame of the motor. Mr. E. Kilburn Scott defended at length the polyphase motor for traction purposes, which he considered to be superior to any commutator motor for this purpose. He stated that in Italy the three-phase motor had achieved magnificent success in the service. Mr. Ward Leonard sketched the characteristics of his system of railroad traction, consisting in transmission to a train of high tension single-phase alternating-current driving on the train a single-phase motor direct-connected to direct-current generators supplying the train motors. Mr. B. J. Arnold said that he did not consider there would be any difficulty in using 600 or 700 volts in single-phase motors, and considered the use of low voltage in such motors undesirable from the standpoint that low voltage current must be frequently broken. He maintained that the polyphase system with its two wires overhead was impracticable for railroad work. Mr. Henry Pickler pointed out that the polyphase motor has and is giving excellent service in railway traction, though no one would think of using it where stops are frequent. He considers that the two variations of speed which it admits of, that is, high speed and half speed, are entirely satisfactory for many conditions of railway service. Mr. H. Armstrong said that his company had given very thorough study to the subject of polyphase traction. The chief objection to its use is the motor constant speed characteristic, the restricted output of the motors and the poor power factor. The constant speed characteristic is particularly objectionable in the case of grades. On the other hand, the commutator alternating-motor is especially adapted to railway work and it comprises most of the characteristics wherein the three-phase motor is deficient. Mr. Eck, referring to several references to the loss in the rail through the use of alternating-current, said that such loss is less in alternating current at 1000 volts than in direct current at 500 volts. Mr. Steinmetz stated that his company had experimented for more than ten years with polyphase railway motors and that they could never honestly recommend a customer to install a system employing this motor. It is true that a polyphase induction motor is a very beautiful apparatus when run at constant speed; it is possible to run it at half speed by a certain arrangement of two motors, but this method is not satisfactory. He also considered very objectionable the use of two wires, which are necessary in the polyphase system. Referring to the Leonard system he said that he fully agreed with the statements made as to its beautiful control of speed and power; this, however, is not the problem of electric railway service, where the chief conditions are quick acceleration, efficient running at high speed and quick stoppage. It is not desirable to run at any low speed continuously; what is needed is a railway motor system as simple as possible. The single-phase commutator motor gives a high efficiency of operation under normal conditions.

SECTION G.

On Monday but two papers were presented, those by Mr. Saitaro Oi, of Japan, and Mr. Joseph Hollis, of Hungary. Mr. Francis W. Jones, chairman of the section, referred to the great progress in Japan of telephony and telegraphy and remarked that the work of the Japanese along these lines is both very methodical and very complete. The paper by Mr. Hollis described the application in Hungary of a system of simultaneous telephony and telegraphy using complete metallic circuits. This system does not appear to differ essentially from the usual Van Rysselberghe system. Mr. Hesketh said that in Australia a ground circuit and not a complete metallic circuit is used for simultaneous telegraphy and telephony. A system also in use in Australia is where two telephone circuits are operated over three metallic conductors. Major Reber said that in the army the grounded circuit for simultaneous telephony and telegraphy had been used with success. Mr. Gherardi called attention to the fact that such a system is also employed on some railroads.

The first paper presented on Tuesday was that of Dr. Kennelly on "High Frequency Telephone Tests." This gives a method for making measurements and tests of precision of telephone circuits and apparatus in cases where previously only crude methods had been used. In the discussion Dr. Kennelly said there is no benefit to be derived from loading short lines with inductance. Mr. Gherardi referred to the interest and value of Dr. Kennelly's paper and said that it will serve a useful purpose through giving methods of testing lines which will give evidence of their condition directly. Mr. Hesketh said that the paper presented a most valuable and practical method of testing telephone lines under practical working conditions, and that a great need had existed for such a method.

Mr. John Hesketh, of Australia, then presented his paper entitled "A New Danger to Lead Covered Aerial Cables." In the discussion Mr. Hesketh said that cables were attacked whether the lead sheathing were bare or taped. Mr. Wotton said that considerable trouble had been experienced in the South with an insect which bored through the lead sheathing of the cable. Mr. Green spoke of a case where gray squirrels attacked the lead sheathing of cables. Mr. Gherardi said that no damage from insects had yet been discovered in New York or vicinity. Mr. Jones said that there had been frequent reports concerning damage done to cables through perforations; these had been ascribed to sportsmen making marks of the cables, but it might possibly be that in some cases an insect was the cause.

The next paper presented was that of Major Samuel Reber, U. S. A., on "The Telegraph, Telephone and Cable in War." In reply to an inquiry by Lieut. Com. J. L. Jayne, U. S. N., Major Reber said that the operation of wireless telegraphy over long distances had not proved successful for military purposes, though the opposite was the case for short distances up to 35 miles. The telephonic receiver is much better for field work than the coherer. At the conclusion of the discussion of Major Reber's paper Mr. P. B. Delany presented his paper on "Rapid Telegraphy." Mr. F. W. Jones said that in comparisons as to the conduct of the telegraph in different countries it must be borne in mind that in this country the telegraph is operated as a private enterprise and not as a State department. In the latter case there is apt to be no recourse in case of error for damages, while the reverse is the case in this country.

The next paper presented was that by Dr. Louis M. Potts, entitled "Printing Telegraphy." This includes an account in brief of the various recent systems of printing telegraphs that have been put before the public. This was followed by a paper by Prof. Ferdinand Lori, of the University of Padua, describing a harmonic rapid telegraph invented by the author which, it was stated, had given very favorable results on experiment. This paper was read by title, and then Mr. F. J. Dommerque read his paper on "Telephone Problems in Large Cities." This paper deals with the complications introduced by the ever-extending service of large cities, and advocates as a partial solution a combination of the manual and the automatic systems, the latter being used for trunking and the manual for other work. Mr. John Hesketh said that between the one-office system and the multiple system there is a mean which is to be determined by local conditions in each case. Mr. Dommerque, in reply to an inquiry, said that in four-division work the percentage of mistakes is perhaps 40 per cent. When the wrong call comes in, or a call on the wrong board, the operator transfers it to the transfer table, where the line is connected to the right operator. The serious trouble to contend with is that sometimes the subscriber pushes the right button, and, not getting a response immediately, pushes the second, third or fourth button, thus calling several operators at the same time.

Mr. Gherardi said that at St. Louis about 50 per cent of the calls are being trunked. He did not believe that a sub-divided switchboard would diminish the trunking percentage very materially. Mr. Hesketh did not think that anything affecting the reliability of the telephone operation should be left to the subscriber.

The discussion of Mr. Dommerque's paper was resumed at the session on Friday, when Mr. H. Lincoln Reber, in reply to a question as to the total amount of trunking from section to section in the St. Louis multiple exchange, said that it amounts to one-half of one per cent, and 8 per cent of this was due to the subscriber, and 12 per cent to the equipment. He described how the trouble was overcome in practical operation.

The next paper presented was that by Mr. J. C. Barclay on "Modern High Speed Printing Telegraphic Systems." This was followed by a paper entitled "Automatic vs. Manual Telephone Exchanges," which, in the absence of the author, Mr. Kempster B. Miller, was read by title. This paper discussed the present status of the automatic telephone exchange and gave very encouraging opinions as to its future. The author not being present at the meeting, the discussion of his paper was taken up on Friday, and was quite extensive. Those taking part were Messrs. Miller, Dommerque, Gherardi, Delany, MaNaier and Major Reber. In the discussion Mr. Miller upheld the cause of the automatic exchange, which was subject to criticism by the other speakers, with the exception of Mr. Delany, who considered that the present system of automatic telephony gave very little indication as to what the outcome of the future would be, and Mr. McNaier, who thought that in the time to come, when every house would have at least one telephone, the automatic exchange will be perfected in order to handle the conditions this situation will bring about.

The session on Thursday was devoted entirely to wireless telegraphy. The first paper presented was by Marquis Solari, entitled "Wireless Telegraphy of the Italian Government," which included a very complete historical and technical description of the Marconi system. The next paper was that of Mr. John Stone, entiled "Theory of Wireless Telegraphy." This paper deals largely with the system of selective wireless telegraphy with which the name of the author is connected. Dr. Lee De Forest then read his paper entitled "Electrolytic Receivers in Wireless Telegraphy," in which he gave the history of the electrolytic receiver and discussed at length the nature and theory of its action.

The next paper on the programme was that of Prof. J. Fleming, on the "Present State of Wireless Telegraphy," which was read by title. This paper gives a very complete account of the Marconi system from its inception to the present day.

The paper of Mr. Hammond B. Hayes, entitled "Loaded Telephone Lines in Practice," was next read. In the discussion Dr. Kennelly spoke highly of the value of the paper, not merely from the practical, but also from the theoretical standpoint. Mr. Stone referred to the serious loss which occurs when the current passes from the overhead line into the cable, or from the cable into the overhead line, and said that to overcome this it is practically sufficient to determine upon a certain ratio between the inductance and capacity of the overhead line and the inductance and capacity of the cable. Mr. Gherardi said that the cables crossing the North River, New York, had inductance coils at each end.

The first paper read at the session on Friday was one by Mr. M. G. de la Touanne, entitled "Theory of Telephone Exchange." A joint meeting was then held with Section F of the Congress, at which a paper was presented by Prof. G. Sever, entitled "Electrolysis of Underground Conductors," which treated of the question exhaustively and largely with reference to the results of electrolytic surveys. In the discussion Mr. Hesketh pointed out that the injurious results of electrolysis cannot possibly be considered as chargeable to only one party, and its avoidance must be by mutual arrangement. It is impossible for a telephone company to protect its lines by any known reasonable methods, if the railway companies on their part neglect well-known methods. He favored measuring the difference of potential between the rail and the earth nearest to the rail as the more correct method. Prof. F. C. Caldwell said that the amount of damage from electrolysis would depend very largely upon the nature of the surrounding soil. In some tests with the soil from Dayton, Ohio, there was a large amount of electrolysis, while the soil at Columbus gave very small amount. Mr. Harrison said that it does not matter practically how much current flows in the pipe, for a very considerable length the line may be a fair insulator, and there will then be a patch which is conductive to a high degree, and here the current density and damage will be greatest. Prof. Sever said that in New York the sheaths of some underground cables were bonded to the elevated structure by copper wire, and that 1500 amperes passed through the wire. In spite of precautions taken in New York telephone cables these convey very large currents, even amounting to thousands of amperes. Mr. Gherardi said it was not unusual for currents of several hundred amperes to flow in the sheathing of telephone cables, and that the aggregate amount of the current carried in New York telephone cables amounts to thousands of amperes. Notwithstanding this, through coöperation of the street railway people, they had succeeded in taking care of the situation, so that it does not constitute a serious difficulty to telephone service. He considers that with the assistance of railway companies the trouble from electrolysis may be reduced to such a point as not to be a vital question. Prof. Sever described precautions taken at Richmond, Va., to avoid electrolysis. Four points were selected almost at the corners of a rectangle, and very heavy return feeders carried from these points directly back to the power house; the tracks were also heavily bonded, and the problem by this method seems to have been solved. Prof. Sever said that in Brooklyn a lead pipe had been taken up, part of which had entirely disappeared through electrolytic action. Mr. J. S. Edstrom, of Sweden, said there had been very little trouble in Europe from electrolysis, which he assigned to the very solid construction there, both with respect to bonding and cables carrying return current to the power station. In Berlin no more than two volts difference of potential is allowed between two points on the rails in a city system, and this rule has been adopted in most German cities and in Switzerland and Sweden. In Sweden there are two heavy copper wires at each joint, and the rails are bonded between each other and also the double tracks at certain intervals. At bridges or in passing over water piping the rails are insulated with asphalt as much as possible. The rails in the street are generally insulated by means of a layer of concrete under them. The return feeders are generally of the same dimensions as the outgoing feeders. He did not, however, consider that the two volts of drop allowed is sufficient. Mr. F. W. Jones gave the experience of the Postal Telegraph Company with respect to electrolysis since 1880. In most cities where underground telegraph cables were laid parallel with, or near to electric railways, sections were eaten and the service stopped. It was found, however, that by securing a good return wire from the points at which the currents were leaving the cable sheaths, back to the railway generator, the underground system was rendered entirely immune. There has been no trouble since this remedy has been applied. As a matter of fact, the telegraph company loans the sheaths of its cables to the railway company to allow it to get the current back to the generating station, the sheaths being bonded to their return wire, and by this means damage to the cables is avoided. He doubted whether there is any serious electrolysis caused by telegraph currents.

Mr. L. W. Stanton presented a paper entitled "Modern Telephone Engineering," which was read from manuscript. The final paper of the session was that read by Mr. J. C. Kelsey, entitled "Two-Strand Common Battery System." In the discussion Mr. Dommerque said that the two-wire system described renders it possible to build boards having 18,000 lines connected. The system was developed by Mr. Dunbar and Mr. Miller, and has given excellent service wherever it has been installed. Mr. McBerty said that the advantage of the two-wire over the three-wire system would not be established until switchboards were called for exceeding the capacity of the three-wire system, and this he said had not yet been done; otherwise the three-wire system would still have the advantage.

JOINT MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AND THE INSTITUTION OF ELECTRICAL ENGINEERS OF GREAT BRITAIN.

At this meeting, President B. J. Arnold, of the American Institute, delivered his annual presidential address, in which he reviewed briefly the progress that had been made in electric traction and expressed optimistic views as to the future of that branch of industry. On motion of President Gray, of the British Institution, and Col. R. E. B. Crompton, past president of that Institution, the members present tendered Mr. Arnold, by acclamation, a hearty vote of thanks for his address.

The subject for discussion at this meeting, "Different Methods and Systems of Using Alternating Current in Electric Railway Matters," was then taken up, Dr. Charles P. Steinmetz opening the discussion. Mr. Steinmetz reviewed at some length the development of the alternating-current railway motor, starting with the early work of Messrs. Rudolph Eickemeyer and Charles Vandepoele, and leading up to the latest type—the compensated commutator motor. He discussed the characteristics of the direct-current series railway motor, the polyphase induction motor, and the commutator alternating-current motor, and their adaptability to different classes of railway work, these classes being ordinary city street service, rapid transit service, as on elevated and underground tracks; suburban and interurban service, trunk line passenger service and long distance freight service.

For city service the characteristics of the direct-current series motor are best on account of its enormous torque at starting, its rapid acceleration, and maintenance of torque from the limit of acceleration to the free running speed. These features were absent in the induction motor. This latter type of machine cannot combine very high acceleration with high efficiency at free running, or with the ability to run efficiently at low speeds. The alternating-current commutator motor, however, while having not quite such good characteristics as the direct-current series motor, is well adapted for city service. The problem and conditions in rapid transit service are the same as those in city service except that the units are larger, the speeds higher and the stops are not so frequent.

In interurban and suburban work there are fewer stops, so that rapidity of acceleration is of less importance and a lower torque of acceleration will do, but the same surplus torque is required as in city service, because the voltage cannot be maintained so nearly constant on interurban lines as in the city. The induction motor being most sensitive to voltage variation (the torque varying as the square of the voltage) is not at all adapted to interurban and suburban service, the maximum torque which the motor can give cannot much exceed the acceleration torque without spoiling the characteristics of the motor, and while the motor will run at constant speed regardless of voltage fluctuations, an excessive drop in voltage will cause it to "break down" and refuse to carry the load. The alternating-current commutator motor, however, appears to be pre-eminently constituted for this class of work.

In trunk line passenger service, the rate of acceleration at present obtained by means of steam locomotives is much lower than that obtained in everyday practice for electric railways, and as excessive acceleration torque does not need to be sustained up to high speeds in this class of service, it is a field where alternating-current commutator motors should be employed, and possibly induction motors if the question of voltage maintenance does not interfere.

In trunk line freight service the same considerations come in, except that the speeds are relatively low and the train weights are enormous, so that here more than in any other class of work it is essential to have a very large surplus torque available in order to start the train or to hold it on an up grade. For this service, therefore, as in interurban service, the motor must run efficiently at light loads and be able to give a very high torque, although it need not carry this torque up to high speeds.

Mr. Steinmetz then pointed out that on account of the enormous mileage of direct-current railways already existing in cities, this type of equipment would always remain; consequently, long distance motors, that is to say, motors running over connecting links between different city systems, must be able to operate on the direct-current system. The alternating-current commutator motor is highly advantageous since it possesses this peculiar characteristic. He also expressed the opinion that since 25 cycles had been adopted as the lowest alternating current frequency in this country, and there is a great deal of 25-cycle generating apparatus now in use, alternating-current railway motors must be built for that frequency. Dr. Steinmetz expressed the belief that the alternating-current motor would not make any very serious inroads into the field occupied by the direct-current motor. He thought the alternating-current machine will develop a field of its own, just as alternating-current transmission and distribution have supplemented rather than displaced direct-current distribution.

Mr. B. G. Lamme then reviewed the development of the street railway car equipment from the early direct-current systems up to the commutator type of alternating-current motor, and described some of the experimental work which he had done in 1896 with the latter type of machine. He also pointed out that the pure series alternating-current motor is preferable to the repulsion type of motor for the reason that it operates upon either alternating or direct current, while the other is exclusively an alternating-current machine. He then described in detail the method of control used in connection with his series alternating-current motor.

Dr. C. V. Drysdale, of the British Institution, then referred to the Ward Leonard single-phase system, consisting of single-phase motor driving a direct-current generator at constant speed, and direct-current motors taking their supply from the generator, and laid stress on the advantages of this arrangement.

Mr. Frank J. Sprague expressed the opinion that the adoption of electricity on any trunk line will be determined only by financial necessity, and thought that some of the largest expenditures by some railroad companies will be in the purchase and control of competing electric railways. The subject of alternating-current railway motors, he said, he felt unprepared to discuss.

Professor Elihu Thomson referred briefly to his early investigations of the repulsion motor, and a paper was then read by Col. R. E. B. Crompton on "Standardization of Dynamo Electric Machinery and Apparatus." The paper was discussed jointly by Sections B and E of the International Congress on the following day.

THE EXPOSITION SERVICE PLANT.

The steam and electric generating station of the Exposition service plant was designed and installed by Westinghouse, Church, Kerr & Co., and consists of a model plant of 14,000 horse-power capacity, representative of the most recent engineering practice, such as may be found in only a few large cities. The plant includes four 3500-h.p. Westinghouse-Corliss vertical cross-compound reciprocating engines within the Westinghouse enclosure at the west end of Machinery Hall, smaller engines driving exciters in Machinery Hall, engines driving pumps, stokers and cooling tower fans in the service plant section of the Steam, Gas and Fuels Building, just west of Machinery Hall, and Roney mechanical stokers in the latter building. The mechanical draft and cooling tower plants were built from special designs. The auxiliary electric apparatus and switchboard equipment were supplied by the Westinghouse Electric & Manufacturing Company.

The Exposition service plant, although it furnishes the main source of power for the World's greatest fair, and carries all of the commercial operating and lighting load on the grounds and Pike, as well as a large part of the decorative night illumination of the main exhibit buildings, is of interest to engineers, not so much for its size as for its completeness, and because it resembles in general design such big installations as the 40,000-h.p. station of the Metropolitan Street Railway system just completed at Kingsbridge, New York City, or the 75,000-h.p. station of the New York Edison Company.

Boiler Plant.

Steam is furnished by sixteen 400-h.p. Babcock & Wilcox water-tube boilers of the forged header type, set with two boilers in a battery. The tubes and drums are carried by steel frames independent of the brick setting. Two 10-inch loop steam mains, each connecting four batteries of boilers, deliver steam to the two 12-inch mains which carry the steam to the main units in Machinery Hall. Each group of four batteries of boilers is served by an independent induced mechanical draft equipment. Each equipment is provided with two fans, each capable of operating the boilers at their full capacity. A damper, by means of which either fan may be cut in or out of service, is so arranged that, if desired, both fans may be run simultaneously.

The firing of the boiler plant is accomplished by means of Roney mechanical stokers, each group of four stokers in line being driven by a small Westinghouse Standard engine, through suitable gearing. The stoker embodies the principle of the narrow rocking grate, stepped at such an angle as to facilitate a uniform descent of fuel from the coking arch at the top to the dumping gate at the bottom, the coking arch, which embodies the principle of the reverberatory furnace, being highly instrumental in securing perfect combustion of the volatile distillates contained in bituminous coal. On the Exposition grounds the production of smoke is discountenanced, and careful observations of the smoke from the stoker chimneys are made at intervals during the day's run, for purposes of comparative record.

Condensing System.

All main and exciter engines, as well as auxiliaries in Machinery Hall, operate condensing, two complete central condensing equipments being installed, each of 7000 horse-power capacity and serving one-half of the plant. They are of the Worthington elevated jet or "barometric" type, provided with entrainers and rotative "dry air" pumps for removing air from the condenser cones. Both horizontal and vertical types of pumps are in operation, one of the three being held in reserve. In case of loss of vacuum an automatic relief valve allows the exhaust steam from the engine to escape through the roof. A motor-driven valve operated from the floor below by a switch controls the steam inlet to each condenser. Circulating water is supplied to the condensers by a centrifugal pump of the Worthington turbine pattern, direct driven by a Westinghouse compound engine. The hot water discharged into the condenser hot wells is not thrown away, but is cooled for further use in four specially designed cooling towers adjacent to the boiler room. A second turbine circulating pump elevates the hot water into the towers and, in falling, the temperature is reduced by evaporation, which process is further aided by forced draft from the fans located at the base of each tower and driven from the boiler room

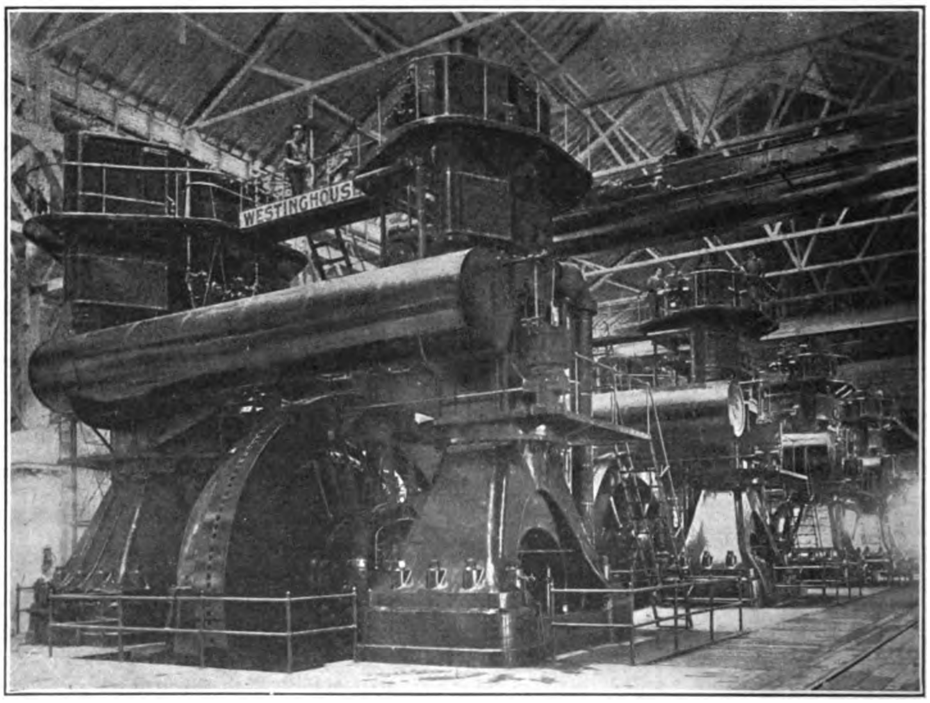


FIG. 1.—VIEW OF MAIN GENERATING UNITS.

by a Westinghouse compound engine. A third turbine pump unit is held in reserve and may be employed on either condensers or cooling towers. Motor-driven valves operated by a switch from the floor control the outlet of each pump.

Steam Piping System.

Two complete systems of steam mains, 12 inches in diameter, convey steam to the main engines. The mains are carried beneath the floor in pipe galleries, anchored firmly to prevent creeping, and supported upon rollers to accommodate expansion and contraction. Entrained water collecting in the boiler room piping is drained out and automatically returned to the boilers by a steam loop and "Holly" gravity return system, which may be seen in continuous operation in the boiler room. A similar system of piping for the boiler room and pumping auxiliaries is connected to the boilers between the drums and main valves, so that steam is always available at the boiler house auxiliaries. These operate non-condensing, exhausting into two Cochrane open feed-water heaters. In the engine room all auxiliaries operate condensing upon the main condensing system.

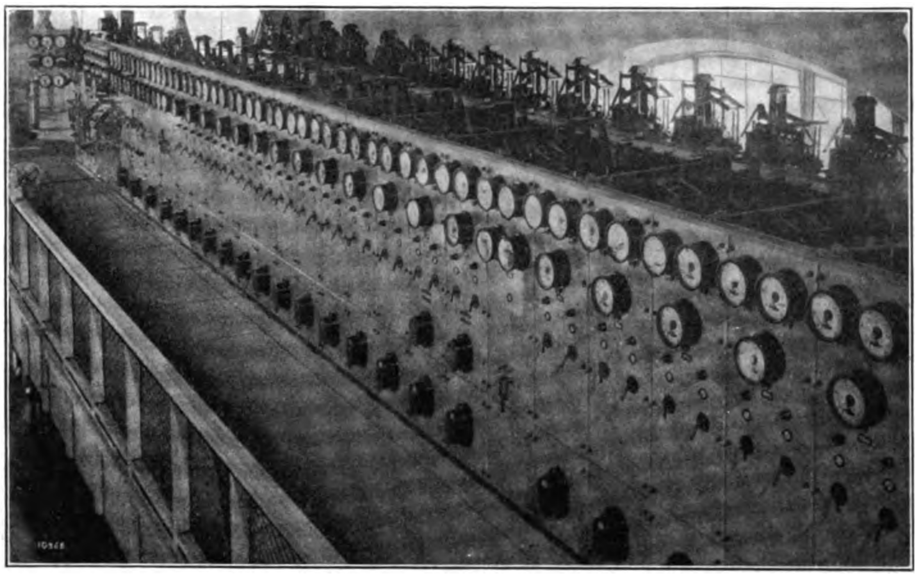


FIG. 2.—VIEW OF MAIN SWITCHBOARD.

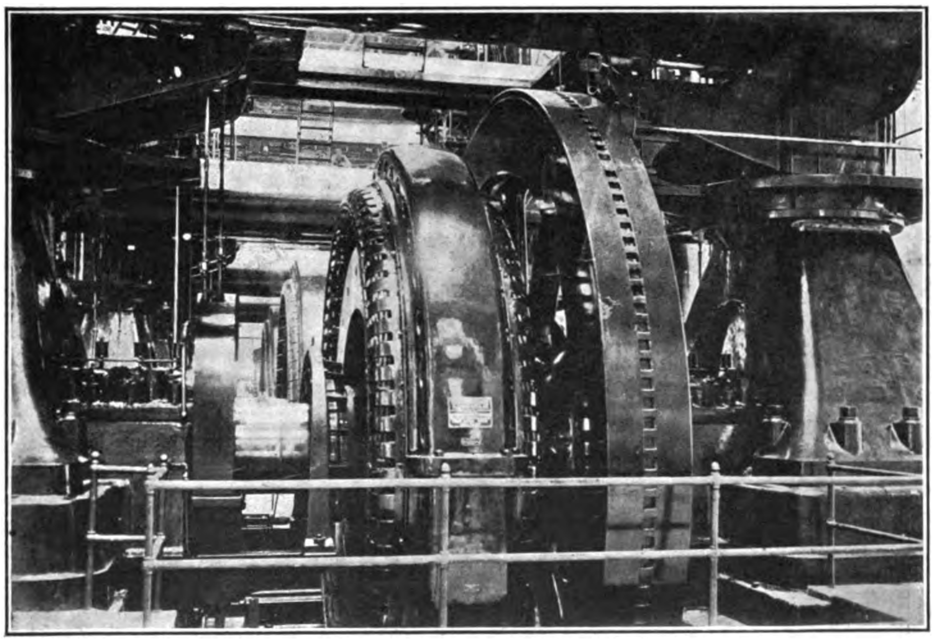


FIG. 3.—NEARER VIEW OF MAIN UNITS, SHOWING GENERATORS.

Generating Units.

The four main units are alike in capacity and general design. The engines are of the vertical "cross-compound" type, and operate at 85 revolutions a minute. As the generator and fly-wheel are mounted between cylinders, a connecting "receiver" is necessary, which is built of riveted boiler steel plate. Bed plates, one on each side, support in order the journals, engine frames, cross-head guides and cylinders. The shaft, which is nearly three feet in diameter at the center, is forged hollow from open hearth steel, fluid compressed to insure perfect homogeneity of metal. On account of the long span the bearings are self-aligning, having spherical instead of cylindrical seats, permitting slight fixture of the shaft due to the load concentrated at the center. Both the bearing shells and the cross-head guides are arranged for water cooling.

Rocking valves of the Corliss type are located directly in the cylinder heads, which connect with "side pipes" paralleling the cylinder walls, a trip release gear on the inlet and a toggle motion on the exhaust controlling these valves. The gear permits a maximum cut-off of three-quarter stroke, enabling each engine to sustain for short periods a load of 5000 horse-power. The speed of the unit is controlled by an enclosed self-oiling centrifugal governor, adjustable while running.

In order to facilitate paralleling the generators, a small motor is provided at the engine, which moves an adjustable weight on the governor mechanism. This motor is controlled from the switchboard, so that the engine speed may be adjusted until the incoming generator has been synchronized and connected to the system. An automatic speed limit is provided on the engines, which instantly closes the throttle should the safe speed be exceeded through breakage of the governor mechanism. This mechanism may be operated also by the engineer from the main floor, by means of an electric switch.

The generators, which are rated at 2000 kilowatts at the usual temperature rise, are of the engine-type revolving-field-magnet construction, with laminated field magnet cores, the armatures strap wound in partially closed slots, and the magnets wound with copper strap on edge. In order to obtain access to the winding the entire generator frame may be moved out of position parallel to the shaft. Three 80-kw. 125-volt Westinghouse engine-type units furnish exciting current for the generator fields.

Electric current from the Exposition service plant and from exhibit power plants in Machinery Hall is transmitted over the network of underground cables at a potential of 6600 volts, transformers being used only at distributing points. All Exposition power is controlled from the twenty-nine panel marble switchboard on the upper gallery over the west end of the main aisle.

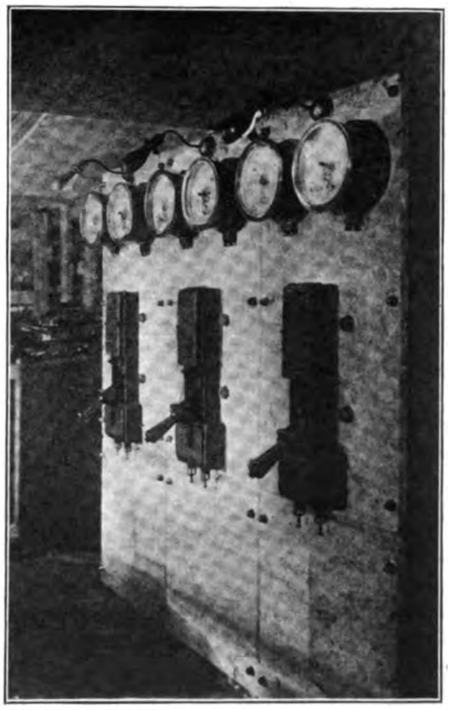


FIG. 4.—SWITCHBOARD IN PUMPING PLANT.

(Fig. 2). The electrically-operated oil switches are behind the operating panels, the bus-bars and instruments on the lower gallery; the bus-bars in duplicate and housed in a structure of masonry with intermediate barriers. All main generator and feeder switches are installed in independent fireproof vaults, and are electrically operated from the main panel, indicators showing whether a switch is open or closed. Remote or relay control of high-tension current is exclusively employed. The switchboard is supplied with Westinghouse and General Electric instruments and control apparatus.

In the design of the service plant, no important feature of a modern central station was omitted. The Niles electric traveling crane over the main engine units in Machinery Hall is of 40 tons carrying capacity and bridges a span of 80 feet. It is equipped with three Westinghouse motors: one of 20 horse-power capacity, to drive the bridge, located at about the center of the girder, and two, one of 20 horse-power capacity for hoisting and one of 5 horse-power for moving the trolley, being mounted on the trolley itself. The motors are controlled from the crane cab, of course. Current at 110 volts is supplied to them by the exciters for the main engine units.

Summary of Dimensions, Rating, Etc.

Main Engines:

Diameter of high-pressure cylinder, 38 inches.

Diameter of low-pressure cylinder, 76 inches.

Stroke, 54 inches.

Shaft, 31 inches diameter and 25 feet in length. Fluid compressed open hearth steel. Weight, 50,600 pounds.

Speed, 85 revolutions per minute.

Boiler pressure, 150 pounds.

Vacuum, 26 inches.

Cranks, counter-balanced disc, 90 degrees angularity.

Fly-wheel, 23 feet diameter. Weight, 170,000 pounds.

Fly-wheel effect, 13,110,000 pounds.

Weight of engine, without fly-wheel, 576,000 pounds.

Weight of engine, with fly-wheel, 746,000 pounds.

Generators:

2000 kilowatts each, revolving field, engine-type, three-phase; voltage, 6600.

Frequency, 25 cycles per second.

Overload capacity, 50 per cent. for one hour.

Total weight, complete, 196,000 pounds each.

Exciter Units:

Three 6-pole 125-volt generators, of 80 kilowatts each, direct-connected to three 12-inch and 20-inch by 12-inch Westinghouse compound engines; 300 revolutions per minute; operating condensing.

Barometric Condensers:

40-inch Worthington elevated jet or barometric type, supplied with injection water by a 30-inch main from circulating pumps. Overflow from hot wells returned to circulating pumps by wood conduit. Main valves operated from floor by electric motors.

Dry Air Pumps:

One Worthington vertical, single-stage, rotative type. Steam cylinder, 8 inches x 12 inches. Air cylinder, 16 inches x 12 inches.

Two Worthington, horizontal, single-stage, rotative type. Steam cylinder, 10 inches diameter; air cylinder, 22 inches diameter; 18 inches stroke. Pumps operate condensing.

Boilers:

Babcock & Wilcox water-tube type, inclined forged steel header. Rated capacity, 400 horse-power each; 6400 horse-power total.

Centrifugal Circulating Pumps:

Three Worthington, direct driven, turbine type, 24-inch discharge. Capacity of each, 17,000 gallons per minute under a 50-foot total head. Each pump driven by a Westinghouse single-acting, compound engine, 18 inches and 30 inches x 16 inches. Governor arranged to vary speed according to pump output.

Boiler Feed Pumps:

One Worthington vertical duplex "Admirality" type. Steam cylinder, 14 inches diameter; water cylinder, 10 inches diameter; stroke, 18 inches.

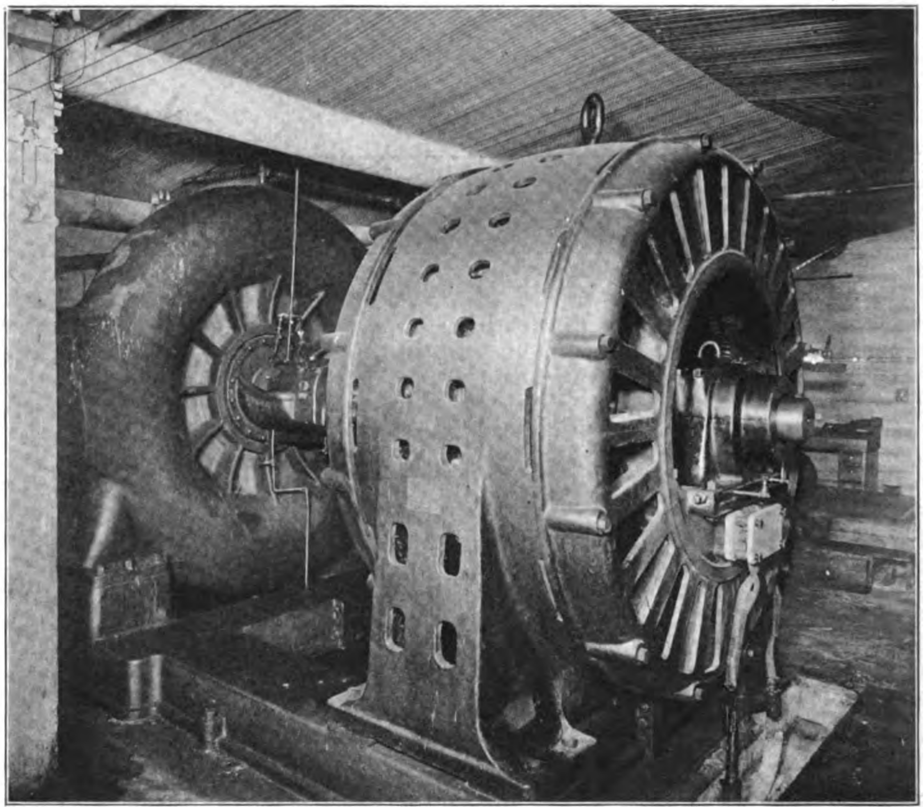


FIG. 5.—2,000-H.P. INDUCTION-MOTOR PUMPING UNIT.

Two Worthington horizontal, compound, duplex, outside packed plunger type. Steam cylinders, 9 and 16 inches in diameter; water plungers, 7½ inches diameter; stroke, 15 inches.

Forced Draft Cooling Towers:

Effective area of each tower, 460 square feet; each equipped with four 120-inch Seymour disc fans. "Make-up" water, replacing the amount evaporated, is supplied from city mains.

The Cascades Pumping Plant.

The Cascades, which are so beautiful and attractive a feature of the Exposition, are supplied with water by three large Worthington centrifugal pumps. The induction motors by which they are driven are said to be the largest in the world. They are rated at 2000 horse-power each and were built by the Westinghouse Company. The design is substantially the well-known "Type F" motor of that company for variable speed service. The stators are wound three-phase for 6000 volts and 25 cycles, and run at 365 r.p.m. The rotor windings are made up of coils of copper strap arranged three-phase and connected through collector rings of the spider type to grid resistances varied by a hand controller with 34 steps. Each pump is capable of delivering between 35,000 and 40,000 gallons of water per minute. At the present time the Cascades are in operation five hours each day. One pumping unit has been found sufficient to supply all the water needed.

The motors are controlled from a three-panel switchboard located in the pumping station, one panel being arranged to handle each motor. The board is equipped with Westinghouse ammeters, voltmeters and automatic circuit-breakers. The circuit-breakers and motor controllers are interlocked so that it is impossible for an attendant to close a main switch unless all the motor resistance is in circuit.

The pump motors are started very gradually at the advertised hours throughout the day and evening, the current being slowly raised to normal by means of starting rheostats under Festival Hall, which, because of the exceptionally large size of the motors, have many steps. Integrating and indicating wattmeters at the ends of the cables in Machinery Hall record the motor load when the Cascades are in operation.

The pumping station is located under the extreme left of the Cascades and is well worth a visit by engineers who are interested in operations of this kind.

Abstracts from Foreign Contemporaries

Holmes-Page Automatic Starting Switch.—The London *Electrician* in an article describing the electrical equipment of the press room of the London *Graphic* gives a description also of the Holmes-Page regulating switch shown by Figs. 1 and 2 herewith, which has been designed especially for those cases in which a motor is started and stopped frequently as in the "making ready" process of printing. The starter comprises a double-pole switch with no-volt and over-load release working in conjunction with a slow motion rheostat with a dashpot control, so that the resistances cannot be switched out too rapidly however quickly the lever may be turned. When the operating handle is moved from the "off" to the "on" position, a double cam which it carries engages with a projection on the double-pole switch arm and closes the switch, an iron armature carried by the switch arm being brought up against the faces of the hold-on bobbin at the same time. When the operating lever is moved on a little further, the double cam is released, but the double-pole switch is left closed by the action of the hold-on bobbin. When this slight further movement is given to the operating lever, the rheostat arm is set in motion in the direction to cut out resistance, but the rate at which it does this is controlled by the dash-pot already referred to, and may be adjusted to suit any particular conditions. When it is desired to stop the motor, the handle is moved to the "off" position, which first opens the double-pole switch and then rapidly inserts all the starting resistance ready for starting up again. Should the double-pole switch open, in consequence of the failure of the supply or through the action of the overload device, it is impossible to close the double-pole switch again without first inserting all the resistance.

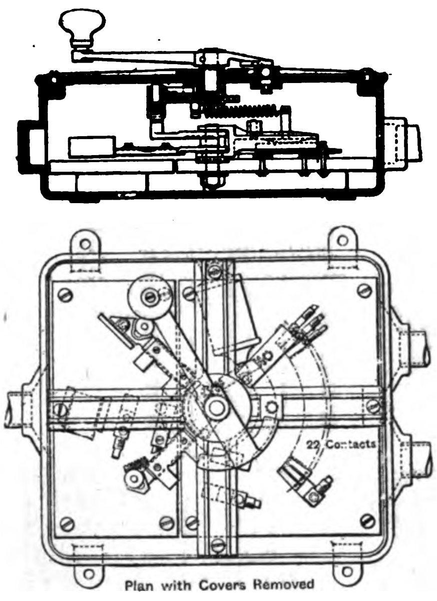


FIG. 1.—AUTOMATIC STARTING SWITCH.

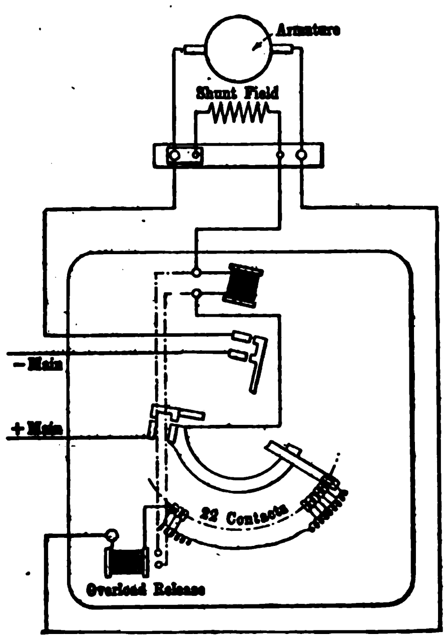


FIG. 2.—DIAGRAM OF CONNECTIONS.

Gas Engine Starter.—The accompanying sketch, taken from the London *Engineer*, shows what is called by its makers the "Perfect" starting apparatus for gas and oil engines. The construction is simple, the only internal working part being a steel ball valve. To start the engine, the crank is placed in such a position that all the valves are closed; the screw plug on the top of the starter is then removed, and the ball pressed down with a prober, which is supplied with the starter. The required quantity of gasoline is then poured into the funnel-shaped reservoir, and by it passed through the projecting pipe into the cylinder end. The funnel pipe is then twisted out of the way. The fly-wheel is then moved a little forward in order to draw in the requisite amount of air through the starter. By bringing the crank nearly back to its original position, compression is obtained and the ball is forced back on to its seating. The prober is again used to press down the ball until its falls by its own weight, then by placing a lighted match over the hole in the starter the engine is started without further manipulation. The screw-plug is then replaced. The quantity of benzine required is small, being, it is said, about a thimbleful to start a 50-horse-power engine and about half this quantity for a 10-horse-power engine.

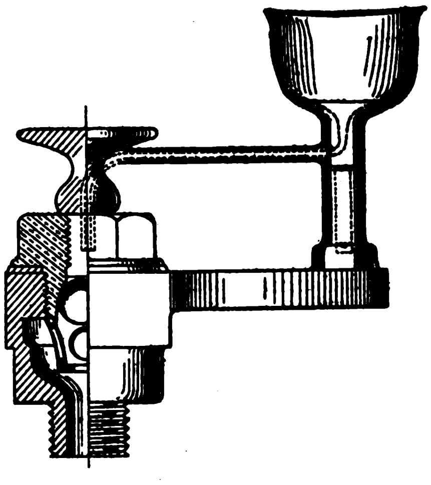


FIG. 3.—GAS ENGINE STARTER.

An Insulator for Conductor Rails.—Among the many problems attending the substitution of electric power for steam locomotives in railway working, of no small importance is the attainment of a thoroughly satisfactory means of supporting and insulating the conductor rails. It is essential that the rail supports, while providing permanent insulation under the difficult conditions prevailing on railway tracks, should be substantial enough to withstand rough usage and sufficiently strong mechanically to resist considerable vibration and shock. The London *Electrical Review* describes the newly patented insulator shown by Fig. 4 in a recent issue. This has been designed with a view to meeting the above requirements. It consists of a pedestal of porcelain of substantial proportions with a large base resting directly upon the rail tie and secured thereto by external malleable iron fastenings. In this respect it differs considerably from earlier types of rail insulators in which the porcelain is supported on a central stud after the manner of telegraph insulators. The conductor rail is held in position by a chair of malleable iron, provided with a depending stud which is cemented into a recess in the insulator. The insulator shown in the illustration is fitted with a chair for a conductor rail of rectangular section. The same type is supplied with chairs adapted for other sections of rail—*e. g.*, flanged or channel sections. The insulator is of high-grade vitreous porcelain of a form well adapted for manufacture, and it will be seen from the illustration that it occupies the whole of the vertical space below the rail, thus presenting a maximum length of path to resist surface leakage of current.

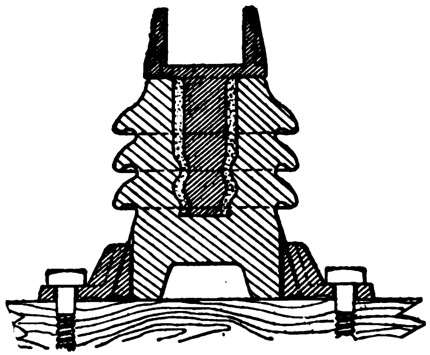


FIG. 4.—THIRD RAIL INSULATOR.

The Testing of Transformer Oil.—The usefulness of an oil as an insulation material is not determined by measurements of its insulation resistance, says the London *Electrical Engineer* in an abstract from the *Zeitschrift für Elektrotechnik*, but by measurements of the voltage required to break down a given thickness. A pair of polished balls should be supported at a fixed distance below the surface in a vessel containing about 200 cubic centimetres, and having a diameter about 3 cm. The presence of water or air bubbles or small fibres greatly affects the results obtained. For the purpose of determining the flashing point of the oil, a weighed quantity of it should be heated for about 12 hours in a water bath at 100° C., and the amount evaporated noted. The point at which steaming commences should be as high as possible, as the flashing point occurs at about the same temperature. The effect of water is so important that the presence of only .06 of 1 per cent reduces the breakdown voltage by half. Further additions of water have little effect. The presence of water may be qualitatively determined by adding a little cupric sulphate to the oil. When free from water this sulphate is pure white, but becomes blue when in contact with water. A good transformer oil may be distinguished by the following properties: (1) It should be a pure mineral oil obtained from crude petroleum by frictional distillation without chemical treatment; (2) the flash-point should not be below 180° C., and the oil should not burn steadily under 200° C.; (3) the oil should be free from alkalies, moisture, or acids; (4) after being heated for eight hours the evaporation should not exceed .2 of 1 per cent; (5) the oil should be as fluid as possible, and should have a light-yellow color.

Lister Two-Cycle Gas Engine.—The Otto cycle, which has practically displaced all other cycles of operation in gas and oil engines, has the great drawback that the piston receives only one impulse during every two complete revolutions of the crank-shaft; hence, not only is close governing rendered difficult, but the engine has to be of excessive size and weight for a given power. Many designs have been suggested from time to time by which the number of impulses per revolution could be increased, the latest which appears in London *Engineering* being an application of the "triangular connecting-rod" motion, originally introduced for the purpose of reducing the number of cranks necessary in a triple or quadruple-expansion steam engine. A two-cycle internal-combustion motor built on this principle is shown by Figs. 5, 6 and 7, which show the internal arrangements. It will be seen that two cylinders, *A* and *B*, are arranged parallel to each other above the crank-shaft, *A* being the exhaust and *B* the inlet cylinder, connected by a common compression chamber at their inner ends. The pistons are joined by the connecting-rods R^1 and R^2 to two corners of the triangular frame, as shown, the other corner being attached to the crank-pin, *C*. The movement of the frame is constrained by the radius-rod, *L*, the other end of which is jointed to the casing of the engine. Ignition of the compressed charge takes place when the pistons are in the position shown by Fig. 6. The crank rotates in the direction of the arrow, so that piston *B* travels faster than piston *A*, and has approached the end of its outstroke by the time the latter piston has arrived at the exhaust-port. Their positions are then as in Fig. 7. When the exhaust-port is uncovered, the pressure drops to atmospheric, and piston *B*, then passing an inlet port communicating with the enclosed crank-chamber, allows a volume of air to pass through the check-valve into the cylinder *B* in order to scavenge the cylinders from the products of the previous explosion. The piston *B* then commences its stroke again in advance of piston *A*, forcing out a quantity of air, and nearing the end of its instroke at the time the exhaust-port is closed by piston *A*. The position of the pistons before compression is shown in Fig. 5. Shortly before the closing of the exhaust-port a charge of gas or oil is pumped into the cylinder *B*, forming an explosive mixture with the air previously drawn in. In engines, the close governing of which is not essential, the charge may be drawn into the crank-chamber with the air, and thence delivered to the cylinder, thus doing away with the necessity for pump-charging, though the advantages of scavenging are lost by this arrangement. The mixture is compressed as the pistons approach the upper end of the cylinders, ignition is effected by any of the usual methods, and the cycle is repeated as before, one explosion taking place to every revolution of the crank-shaft. It will be noticed that the initial volume of the charge is increased by from 50 to 70 per cent before the exhaust, allowing more work to be obtained from the fuel together with a lower exhaust pressure. The ratio of expansion volume to compression volume is 6.8. The design permits of the connecting-rods being kept very short, and they are so proportioned that at no point of the stroke do they make a greater angle with the centre line of the cylinders than 5 deg., thus the pressure on the cylinder walls and consequent wear is very small. The combined effective power strokes of the two pistons are approximately equal to 1.8 times the crank stroke, the compression portion of the return stroke amounting to 1.2 times the crank stroke.

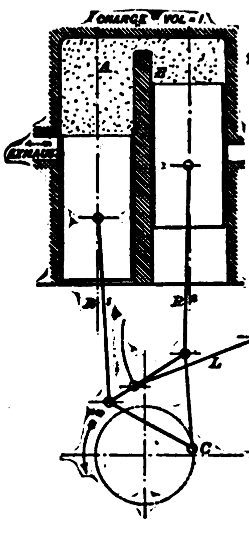


FIG. 5.

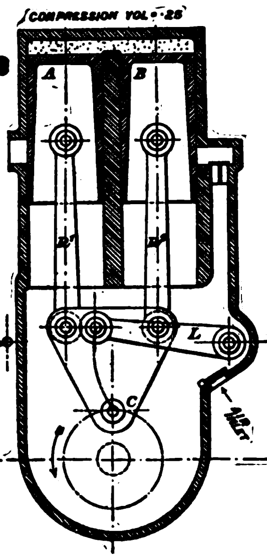


FIG. 6.

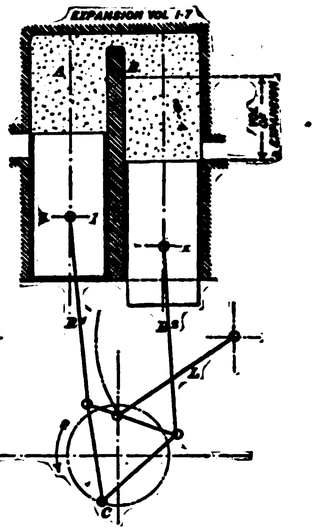


FIG. 7.

Some Notes on Testing.—"C. H. R. T.," in a recent issue of the London *Electrical Engineer*, claims that while many articles dealing with shop testing have been written, there are a few convenient and simple tests which are always carried out but seldom mentioned. When a motor is to be tested for speed it may happen that there is at hand no supply of the proper electromotive force. It may also happen that when a dynamo is to be tested for voltage there is no convenient method of driving it at the proper speed. In the latter case the dynamo may be run as a motor, should there be a suitable supply of power; but should the voltage be too low, the speed of the dynamo or the motor will also be low, and a correction must be made. The correct speed of the dynamo or motor operated in this way will be found from the following formula:

$$DS \div MS = (DV + LV) \div (MV - LV)$$

where DS is the speed of the machine running as a dynamo; MS the speed at which it will run as a motor on its proper voltage; DV the voltage generated as a dynamo; MV the voltage for which the machine is designed; LV the volts lost in the armature and series field coils, if any. It is more convenient to test the speed of a motor by driving it as a dynamo, but the speed is not exactly right. The same formula will give the speed at which the machine will run upon the proper voltage. Before sending out a compound dynamo or motor, it is desirable that it should be tested to see if all connections have been made properly. The convenient way of doing this is to short-circuit the series winding for a few seconds after the machine has been put in operation. In the case of a dynamo the external current will increase if the series winding opposes the shunt. It will decrease if the machine is correctly coupled. In the case of a motor, the external current of the driven machine will decrease if the machine is wrongly coupled and increase if it is correct. For these tests the most convenient have supply mains of fairly low voltage—say about 100—in a convenient place, so that all machines above that voltage may run on them. In making this test care must be taken when a high-voltage shunt machine is connected to the low-voltage circuit. When this is done it is frequently necessary to start the machine by hand, owing to the weak field.

Notes on Steampipe Work.—An interesting article on this subject by M. Westphal appeared in a recent issue of a German contemporary. With regard to material for steam pipes, the author considers that above eight atmospheres and 200° C. copper and bronze should not be used. For higher values mild steel may be used. Referring to drainage, he states that every right-angled bend offers an opportunity for getting rid of water, by employing a blanked tee-piece and trapping the blanked leg. Frequent drainage is essential, and danger of water-hammer can occur if a valve is quickly opened. It is a mistake to suppose that no water accumulates if superheated steam is used. As a matter of fact, with big pipes the steam in the upper part of a horizontal pipe can remain superheated, while there is an accumulation of water at the bottom, and this puts severe buckling strains on the pipes, which should, therefore, be as frequently drained as for saturated steam. He does not regard the centrifugal separator as very satisfactory, and prefers a box with steam entering vertically and leaving horizontally. In order to compensate for expansion the material may in some cases be anchored at one or more places and the run of the pipes arranged so that expansion can safely take place. Where double right-angled bends occur, every use should be made of twisting flanged joints, which may be of special construction, or even ordinary flanges with the holes enlarged. Another form of joint which can sometimes be made use of is the spherical. Long vertical lengths of pipes may be hung from the ends of counterbalanced levers, thus allowing for expansion while affording a good support. If the diameter of pipe is too large, the heat loss of water deposited is great, and may even cause a drop in pressure; if too small, severe vibrations may be set up in the pipes, but no standard figure for velocity is given. He suggests that it is best to work with rather small pipes and keep the boiler pressure somewhat excess of the working pressure at the engine valves. The author considers that the steam separator in front of the engine should be much bigger than it usually is in order to feed the engine more evenly and keep down vibration. Face joints are recommended, or joints with flat metal rings let into one flange.

Testing of Alternating-Current Motors by Direct Current.—In a paper read recently before the British Association, at Cambridge, W. Cramp gives some notes regarding the testing of alternating-current motors by direct current. Since an alternating magnetic field may be resolved into two equal rotating fields, each of 0.7 times the value of the original field, it follows that there is a close connection between the behavior of an alternating-current motor on its normal supply and that of the same motor having the stator supplied with a direct current of the proper value, while the rotor is driven round at the proper speed by some independent means. As an example of this he cites a repulsion motor. On account of the fact that such motors will usually be arranged for constant-pressure circuits, it follows that the total flux vibrating within the primary coils is practically constant. This means that the rotating fields, which take the place of this vibrating field, are also practically constant in magnitude for any given brush position. Thus the behavior of the motor becomes similar to that of a single-phase alternator upon varying load, and consequently obeys the same laws. These laws form a variant upon the circle diagram so well known as illustrating the behavior of polyphase motors. The motor, then, may be treated as if it were a short-circuited single-phase alternator, and the more important tests may be carried out as follows: I.—Arrange the motor so that its stator may be excited with a direct current, equal to $1.41 A \cos 2 d$ amperes (where A is the normal magnetizing current of the motor, d the angle between the brush line and the polar axis), and so that the rotor may be driven by a direct-current motor. II.—Calibrate the direct-current motor so that the power required to drive it at any particular speed is known. III.—Connect it to the alternating-current motor shaft (the alternating-current motor not being excited), and measure the power required at various speeds. (Friction and windage.) IV.—Drive as above (in II.), but with the rotor on open circuit, and stator excited with direct current as explained above. (Rotor hysteresis and eddy losses, hence, also, stator hysteresis and eddy loss.) V.—Close the rotor circuit by connections which revolve with the rotor, and excite (as in III.), and run at what would be synchronous speed. This gives the rotor current at standstill (if desired, for various values of d). It also gives, if the speed is varied, the rotor power-factor at standstill—a most important point. VI.—With the same direct current the resistance of rotor and stator may be measured. Thus all the losses of the motor are completely known, as well as the rotor current and power-factor, and the performance of the motor may be predicted exactly. The method enables a very satisfactory test to be made, when alternating current of the right voltage and frequency is not available, which is an important point, especially in England, where the frequencies are so varied as to make it necessary to have a great deal of apparatus to test even a moderate run of motors. No wattmeter is necessary, which is another advantage.

Some Recent Electrical Patents

Interlocking Electromagnets.—There are many applications of electromagnets in which it is desirable that when one of a group of magnets is actuated all of the others shall be restrained from operation, accidental or otherwise, until the first magnet has been restored to its idle condition. A favorite means of accomplishing this is to cause the magnet first operated to open the exciting circuits of the others. Mr. William Baxter, Jr., however, prefers to bar the action of the remaining magnets mechanically, as indicated in his patent drawing, Fig. 1. The arrangement consists of a locking bar, 50, slidable horizontally and normally held at the right-hand limit of its travel (as the drawing is made) by a weight, 64, and bell-crank lever. The solenoid extensions carry each a pin, 16, which projects into an L-shaped slot in the locking bar. Should one of the solenoids be excited, the rising of its plunger will force the bar over to the left by the action of the pin in the slanting part of the slot; this obviously will lock the other plungers, their pins being then in the horizontal part of the slots. The inventor does not mention the fact that in order to operate a locking mechanism of this kind each solenoid must be very much longer than would be necessary merely to lift the circuit-closing contracts—probably three or four times as long. Patent No. 766,865.

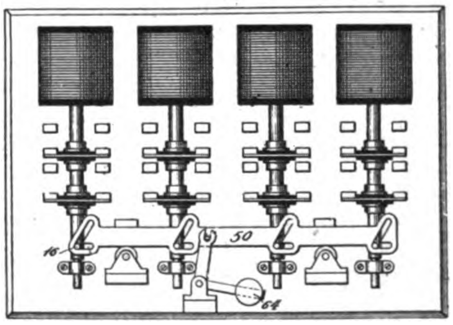
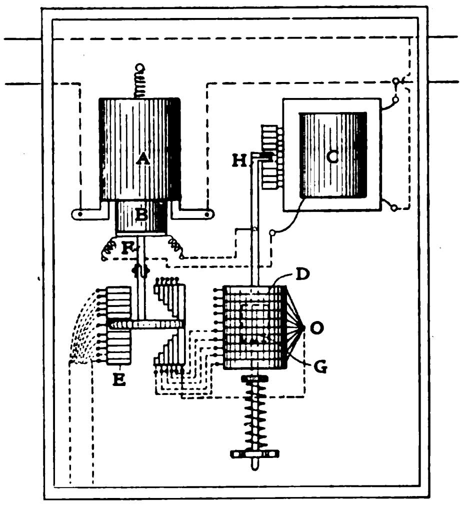


FIG. 1.—INTERLOCKING ELECTROMAGNETS.

Regulator for Alternating-Current Circuits.—The essential requisites for an automatic regulator for alternating-current circuits are: (1) That it shall be susceptible not only to voltage variations, but also to current phase variations; (2) That it shall consume but little energy itself; (3) that it shall be sensitive and dead beat, that is to say, it must not be affected adversely by the change it causes; (4) the action of the regulator should be as little as possible periodic, to prevent unnecessary fluctuations in the line and increased self-induction. A regulator intended to meet these requirements has recently been patented by Ludwig Gutmann, of Peoria, Ill. Fig. 2 shows diagrammatically one of the types covered by the patent. The apparatus is essentially a switchboard device consisting of a main circuit solenoid coil, A; a potential solenoid coil, B, connected across the terminals of a variable ratio transformer, C; a controlling solenoid, D, and contact terminals, E, connected by means of a cable to the exciter of the alternator. It is evident that the pull exerted by coil A on coil B will vary with the pressure across the terminals of coil *B* and also with the power factor of the circuit. The transformer, *C*, with its primary connected to the line, delivers a secondary e.m.f., which varies, of course, in accordance with variations in the line e.m.f. The secondary winding is subdivided and provided with contact terminals to allow adjustment of the ratio of transformation. The solenoid, *D*, consists of a number of superimposed coils having one terminal in common and the others arranged so that the contact arm, *F*, attached to the coil *B* may place them successively in parallel with one another. The core *G* of the solenoid *D* is provided with a contact arm, *H*, which is in sliding connection with the terminals of the subdivided secondary of the transformer *C*, precautions being taken to prevent short-circuiting at successive secondary terminals. Finally, the contact arm *F* is simultaneously in circuit with the terminals *E* of the cable, as well as with those of the coil *D*, the number of contacts being the same in both cases.

The exciter is provided with an ordinary shunt field-magnet winding and also with a subdivided series winding, which subdivisions are connected to the cable ending at the terminals *E*, Fig. 2. The positive brush, the common terminal of the sectional or subdivided series winding and that of the solenoid *D* are all connected together at *O*. The normal conditions for non-inductive load are as shown in Fig. 2, the shunt winding acting alone, no series turns being included, and the solenoid *D* being without any excitation. Now if, because of change in load or phase displacement, the potential drops, then the solenoid *B* will descend, shifting its contact both with *D* and *E*. The consequence is that additional ampere-turns are added to the field of the exciter, causing its e.m.f. to rise and to send a greater current to the field of the alternator, raising the e.m.f of the latter to normal. The effect of the changed position of *F* on the solenoid *D* is that one or more coils receive current from the exciter and pull down the core, *G*, which shifts the contact *H* and thereby reduces the transformer ratio until the secondary e.m.f. is raised to that which caused the regulator to act. Although its excitation is now raised again to normal, the solenoid *B* will not shift its position because its terminal e.m.f. is the same as when the regulator began to act; and as long as the additional excitation is required the solenoid *D* will hold the contact *H* in the fixed position. This feature of reaching stability, after correcting the voltage, is desirable in circuits where many motors are frequently started and stopped, as in a power distribution system operated by alternating currents.



Am. Elec.

FIG. 2.—ALTERNATING CURRENT CIRCUIT REGULATOR.

If circuit conditions alter and the power factor of the circuit increases, for example, the mutual pull between coil *A* and coil *B* increases and the latter is drawn up. This reduces the field excitation of the exciter and simultaneously reduces the pull of the solenoid *D*, thereby lowering the transformer ratio to compensate for the reduction in line e.m.f. The device is capable also of compensating for leading currents in a similar way, the difference being that in such a case the series turns cause a demagnetization of the exciter field, and the solenoid *D* makes contact with secondary terminals giving transformer ratios greater than normal. The regulator may evidently be adapted for polyphase circuits and the actuating solenoid may be substituted by a suitable motor or rotary converter of, say, ¼ horsepower capacity. Obviously, also, instead of using a special form of exciter the field variations of the alternator may be obtained with any standard exciter and a variable resistance included in series with the alternator field winding or the exciter shunt winding. In connection with large machines the same regulator may be used by shunting a part of the total main line current for the purpose of energizing the coil *A*. Moreover, if an alternator and exciter provided with this regulator be placed in a circuit subject to wattless currents and the alternator be operated with over-excited fields as a synchronous motor, it can be made to compensate for phase variation and maintain a fixed power factor by having its field excitation adjusted automatically. Patent No. 769,342.

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Hydraulic and Electric Elevators.

To the Editor, American Electrician:

In your editorial on "The Passenger Elevator" in the September number too much stress has been placed on the disadvantages of the hydraulic elevator, while you have utterly ignored the important disadvantages of the electric elevators. The writer agrees with you that "each system has its legitimate field of operation in which it is distinctively superior to its rival." But when comparisons are made the disadvantages as well as the advantages of both types should be clearly set forth in each case, and discussion should be limited to the types in universal use.

Three advantages for the hydraulic elevator have been cited in the editorial, but the most important one of all was omitted. The fact that the hydraulic elevator car cannot by any possibility run into the top or bottom of the hoistway, provided proper hoistway clearance is given, is assurance of safety, and should be given first consideration.

The hydraulic cylinder should be in length properly proportioned to the rise of the car, so that the piston automatically cuts off the ports and acts as a valve cushioning on water, which may be against the cylinder head.

The "positive limit" has been wrongly ridiculed in the editorial, as all engineers, familiar with detail construction of both types of elevators, will agree; and that advantage is conceded to be the first and most important advantage of the hydraulic elevator. One seldom reads of an accident due to a hydraulic elevator driving its car into the overhead work and pulling the hoisting ropes out of their sockets, as in the case of many accidents with the electric machine.

As to the disadvantages, one cannot emphasize the serious inefficiency of the hydraulic elevator too much, but the second and third disadvantages cited in the editorial are unimportant, depending entirely upon the type of elevator, class of service, and the building in which the elevator is to be installed. In many cases hydraulic elevator machinery will fit in where it would be impossible to install an electric machine.

Of the two types the electric elevator is the most economical, because it is convenient to overbalance the car. The counterbalance is made to balance the car with its average load, in which case the elevator has no gravity work to perform. A serious disadvantage, which was utterly ignored in the editorial, is the lack of absolute means of stopping its hoisting power when the car or counter-balance arrives at the top of the hoistway. The failure of automatic limit devices has caused more accidents than all the other parts of the machinery put together. It is safe to say that four out of five accidents have as primary cause the failure of the automatic limits to properly shut off the power. There is not a drum elevator to which the hoisting and counterbalance ropes are shackled that is not liable to run its car or counter-balance into the top of hoistway and cause accident.

Automatic devices are operated by both the car and the hosting machine to shut off the power and apply the brake at the limits of the car's travel, but they are adjustable, removable and breakable, and nothing but constant care and attention on the part of the engineer in charge can assure their proper action. It is on account of this serious disadvantage, which stands out prominently in proportion to the speed of the car, that hydraulic elevators have been almost universally adopted for office building use, where high speeds and heavy loads are involved.

However, there are two forms of electric elevators that are not hampered with this disadvantage, namely, the Sprague-Pratt screw machine and the friction-drive cable drum type. The Sprague-Pratt screw machine compares favorably with the hydraulic in safety combined with high speeds, because they both have in common the characteristic of positively limiting the car travel and the impossibility of dangerous speed acceleration. With the cable-drum, friction-drive type, and some of the modern forms of traction elevators, although having an elastic operating medium, the car can go into bumpers at full speed without injury or discomfort to the passengers. However, special air bumpers for both car and counter-weight are necessary whereby the landing of either the car or the counter-weight on the buffers slacks the traction cable, and positively arrests the hoisting effort. The driving drums can then keep on revolving indefinitely, and no injury or danger be incurred. This same function also prevents the paying out of slack cable when the car is stopped in its descent by the car safety or other causes other than the hoisting machine.

Summing up tersely: Hydraulic elevators are safe and reliable, but inefficient; especially adapted to office building service.

Electric elevators are efficient, and especially adapted to stores, hotels and all moderate-speed service (with the exceptions here noted).

New York. EDW. VAN WINKLE.

The warmth of Mr. van Winkle's admiration for the hydraulic elevator seems to have impaired his consistency and distorted his interpretation of our remarks last month. After saying that we omitted the "most important advantage" of the hydraulic elevator he states that we "wrongly ridiculed it." We beg to differ with him on both points. We also beg to remind him that possibilities are not necessarily realized facts; no one will deny that the hydraulic elevator has greater possibilities in the way of positive travel limits than the drum electric type, but everyone conversant with the subject knows that there are many installations in which the positive limit to the piston travel does *not* insure positive limit to the car travel short of the bumpers or overhead work. We have conceded that the control apparatus is much more rugged and reliable in hydraulic than in electric elevators and that the former has the great advantage of a non-elastic operating medium, requiring no brake, while the electric system has not; these features are responsible for the fact that fewer hydraulic than electric cars are dragged into the overhead work or run down to the bumpers at full speed, and not the much-vaunted "positive limit."

While admitting the absence of an inherent positive travel limit in the drum electric system, we may say that we have several times noticed installations of this type in which the limit safeties were so thoroughly reliable as to be practically equivalent to a positive travel limit. No one, we think, will dispute that it is only a matter of good engineering to provide a limit device which will make it impossible for the motor to continue running after the car has passed the upper or lower limit.

There is not much gain, however, in arguing on the basis of what might be done under ideal conditions with either system; our editorial remarks were incited by our observation of what is actually done in practice, and we still see no reason to put the positive travel limit of the hydraulic piston at the head of the list of advantages of that system.

As to the relative space advantages of the two systems, we cannot quite appreciate the unimportance ascribed to this feature by our correspondent. We happen to know of cases in which the rental income from the space saved by the use of electric elevators paid for the entire equipment in a few years.

Mr. van Winkle's remarks concerning the Sprague-Pratt screw elevator are not especially relevant in view of the obsolescence of the system.—[EDITOR.]

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The Adoption of 220-Volt Incandescent Lamps at St. Louis in 1899.

To the Editor, American Electrician.

SIR:—In a paper I read before the National Electric Light Association, at Boston, in May, reference was made to the use of the 220-volt lamp in St. Louis. I made the statement that the installation at St. Louis in 1899 was made under the engineering advice of Mr. Bion J. Arnold. Mr. H. H. Humphrey, of St. Louis, advises me that the recommendations covering the adoption of the 220-volt lamp in the installation in question were made by Messrs. Bryan & Humphrey, in September, 1897, and that the system was installed under their direction as supervising engineers. In view of these facts I would be pleased to have you publish this correction.

WALTER I. BARNES.

Providence, R. I.

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NOTES.

International Electrical Exposition.—An international exposition will be held, under the auspices of the Electrical Contractors' Association of New York City, at Madison Square Garden, December 19-28, 1904. The executive committee is composed of Joseph R. Strong, chairman; E. S. Keefer, E. K. Comstock, J. P. Hall, J. C. Hatzel, S. Davis and G. W. Russell, Jr. The managing directors are Messrs Weber and Rush, and the business representative is Mr. M. Spiegel, Madison Square Garden, New York City. It is the intention to make this exposition exclusively an electrical industrial exhibit. Applications for special privileges must be submitted to the managers not later than December 10, 1904.

The Dangers of Gas Stoves.—In a paper read recently before the Engineers' Society of Western Pennsylvania, Mr. Francis C. Phillips discusses the domestic gas stove from a sanitary standpoint and brings out some points that should be of use to advocates of electric heating (within rational limitations). He advocates placing the installation and use of gas stoves under the supervision of the health authorities in all municipalities. In support of this contention he points out that coroner's juries in Allegheny County, Pennsylvania, who have rendered verdicts in cases of fatal poisoning caused by the improper use of gas stoves, have frequently coupled their verdicts with recommendations that a law be enacted forbidding the use of gas stoves without chimney connections. He further states that as modern houses are built, there are usually to be found in every dwelling several rooms without chimney flues, and as heating by gas stoves affords frequently the only practicable method of rendering such rooms habitable, the enactment of such laws would necessitate the further enactment that every room shall have a chimney flue. Gas stoves offered for sale should be subjected to tests and if found to yield carbon monoxide or formaldehyde when used with gas under varying conditions of pressure, should be condemned. That a gas stove can be used without danger of production of the poisonous substances resulting from incomplete combustion should be attested by an official certificate, and without such a certificate its sale should be illegal. The manner of using a gas stove in a dwelling house should be as much a matter of official inspection as the plumbing. Carbon monoxide is the most poisonous gas to which the dwellers in city houses are ordinarily exposed, and its effects are without doubt being unknowingly felt by many as the result of faulty construction and improper use of gas stoves.

Recent British Power Plant Failures.—The annual report of the British Engine, Boiler and Employers' Liability Insurance Company, contains, as in previous years, many valuable deductions. The majority of casualties is due to ignorance. Failures in steam and gas engines are classified thus:

	Steam engines. Per cent.	Gas engines. Per cent.
Due to accidents or causes unascertained	31	29
Negligence of owner or attendants.	18	32
Old defects or wear	30	14
Weakness, bad design, or workmanship	21	25
	100	100

In electrical machinery the failures are classified as follows:

	Dynamos. Per cent.	Motors. Per cent.
Armatures or rotors	62	50.5
Magnets or stators	12.5	11.5
Commutators or brush gear	17	14.5
Miscellaneous	8.5	8.5
Switch gear	...	15
	100	100

and causes of failures are stated to have been due to:

	Dynamos. Per cent.	Motors. Per cent.
Accident	14	12
Dirt and oil	10	15.5
Age and deterioration	24	19.5
Bad workmanship or design	17.5	18
Overloading	3.5	5.5
Not ascertained	31	29.5
	100	100

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The Neuchatel Station.

In the description of the central station plant at Neuchatel, Switzerland, which constitutes our leading article this month, several interesting points will be found. One which will seem rather astonishing is that the company decided to use steam-driven generators after carefully considering the possibilities of gas engines, as indicated by results obtained in other plants. We in this country have been in the habit of conceding that European gas engine practice was something to envy and to emulate as far as possible, but if it be true that the European gas engine and producer cannot make a better showing than boilers and 300-kw. steam turbines using about 16 lbs. of dry saturated steam per brake horse-power per hour, then it is quite possible that we are too modest in our estimate of the standing of American gas engines. It is also comforting to note that recent tests of American steam turbines of the same general type as those installed at Neuchatel showed an economy of 14½ lbs. of dry saturated steam per brake horse-power per hour at full load, and between 12½ and 13 lbs. of steam superheated 100° F. It is only fair to state, however, that the American turbines were tested with 28 inches vacuum and that the vacuum obtained in the Baden and Tschopeln tests were not given by the author of our article. It should be noted, though, that the initial steam pressures were 165 lbs. at Baden and 150 lbs. in the American tests. The Baden test with 68° superheat showed the creditable economy of 23.1 lbs. per kilowatt-hour, or about 14 to 14½ lbs. per brake horse-power per hour. Just here, we regret to have to say that typographical errors and careless proofreading have combined to make the table of results from the Baden tests almost unintelligible; as is unfortunately almost invariable, this was discovered too late to remedy the omissions. It may be well to explain that the numbers 38 and 28 in the second and fourth tests represent the degrees of superheat, Centigrade scale.

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The Electrical Congress.

The Fifth International Electrical Congress, held at St. Louis last month, was, in the main, a success, despite several unfortunate handicaps. If we except the absence of such scientific giants as Lord Kelvin, Kohlrausch and Mascart, probably the greatest single disadvantage was the location of the Congress headquarters downtown. Could the meetings have been held within or near the Exposition grounds and the members have been provided with accommodations near by, many serious delays would have been prevented, the sessions would have been longer and more fully attended and the discussions correspondingly improved. So much for the adverse features. On the other hand, under the most conservative estimate of its value, the Congress will have served to bring out some of the most able presentations of scientific and engineering investigation and development that the technical world has ever known. The running report of the proceedings which we publish in this number gives merely a general survey; it it utterly impracticable to do more in view of the enormous mass of material involved. A clean-cut comprehension of what was really accomplished can be gained only from the official printed Proceedings of the Congress, which will, of course, be issued later.

It is unfortunate that the Chamber of Delegates took no action on any propositions relating to the revision of the present system of units and standards. We had hoped that even if nothing else was accomplished by the Chamber, this one pressing question would be disposed of in a way to satisfy at least the majority of those affected by it. However, a most important step was taken in the promulgation of an entirely feasible plan for international coöperation in scientific and technical matters in the future. This plan is to establish an international electrical commission, composed of relatively few members from each coöperating nation, to constitute a sort of open court for the consideration of such questions as units, standards, nomenclature, etc. Such a commission could obviously be made much more efficient than a succession of Chambers of Delegates to Electrical Congresses, and it is to be devoutly hoped that the movement will prove successful.

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The Storage Battery as a Central Station Auxiliary.

Every central station man has by this time read or heard of the advantages accruing from the use of storage battery cells for taking the peak off the load in both main and sub-stations, smoothing out fluctuations in railway plants, and taking the whole station load during the periods of very small load; within a comparatively short time past, however, another application has developed—one with which the average station manager may not be familiar and which is fully as important as any of the others. This is as an auxiliary to the exciter plant in an alternating-current generating station. A storage battery floated on the exciter bus-bars of such a station is one of the most efficient safeguards against a shut-down that can be provided, and the use of such a battery renders the use of steam-driven exciters unnecessary; it also makes the use of motor-driven auxiliaries safer. It is entirely unnecessary to point out the disastrous possibilities of an accident to the active exciter in a station having all of its alternators excited from a common source; unless a reserve exciter is kept in rotation, ready to be put into service instantaneously, any serious accident to the exciter "on duty" must result in a shutdown of more than a few minutes—unless a storage battery is at hand.

As a means of developing the use of motor-driven steam plant auxiliaries beyond the present limited scope, the storage battery should also prove of much value. Alternating-current motors are extremely poor prime movers for almost every class of station pump, variable speed being practically indispensable. Moreover, it is of importance that many of the auxiliaries shall be capable of operation whether steam is available or not, and absolutely imperative that at least one of each class shall be operable whether or not the main generating plant is in operation. The first of these last-named considerations entails the use of motor-drive and all of them point to the use of direct-current motors for driving the auxiliaries, if motors are to be used. Again, it is highly advantageous to have only a single type of prime mover for the auxiliary service; but it is ordinarily unsafe to use motors exclusively for perfectly obvious reasons. Here the battery comes in strongly. By its use, the exciters may be driven by alternating-current motors and supply current to direct-current motors driving the pumps, as well as to the alternator field windings. With the battery floated on the exciter bus-bars neither momentary exciter troubles nor fluctuations in the line frequency, from whatever accidental disturbance, will interrupt or impair the excitation of the generators; the steam plant auxiliaries are assured of a continuous supply of motor current and they can be operated practically regardless of the operation of any other portion of the plant.

In this connection it may be mentioned that one of the chief drawbacks to the use of storage batteries in central stations is the crude, make-shift practice of using end-cell switches. Like all "temporary" expedients, the end-cell has remained in pernicious activity long after it should have been sent to join the wooden switchboard in well-merited obsolescence. Battery users do not need to have explained to them the serious difficulties—to put it charitably—of maintaining end cells in something approaching the condition of the remainder of the battery; but they apparently need very much to be reminded that end-cell troubles are easily obviated by the use of properly designed adjustable and reversible boosters.

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Utilizing the Waste Heat from Gas Engines.

In a paper read at the International Electrical Congress, by Mr. W. L. R. Emmet, the author suggested that a probably useful field for the steam turbine might be found in the utilization of the waste heat discharged in the exhaust gases and jacket water of gas engines. The author proposed to pass the jacket water into a boiler and there turn it into steam of relatively low pressure by the application of the exhaust gases to the heating surfaces of the boiler; the turbine was to be operated, of course, by the steam thus generated. The idea, substituting steam engines in general for the turbine in particular, is old and seductive, and it may be that the improvement in steam engine economy since it was first suggested has been such as to make it more nearly practical now than it was then. The present writer made the same suggestion six years ago, only to find himself antedated about ten years or so. Taking a concrete case five years ago and basing the computations on the then best practical results obtained with gas and steam engines, it was found that the increase in available work due to the addition of the steam plant could not exceed 20 per cent, and would probably not exceed 15 per cent. Mr. Emmet states in his paper that 30 per cent is a conservative estimate; if this is not too optimistic, the plan is well worth practical trial.

In actual practice, we are inclined to think, the reciprocating type of steam engine would probably prove preferable to the turbine for the reason that composite steam and gas engines could then be built, both divisions delivering power to a single shaft and, therefore, to a single generator. This arrangement would obviously have the advantages of tending to smooth out the widely-varying turning moment due to the gas engine part of the mongrel machine and of occupying considerably less floor space than two separate engines. On the other hand, there might be the disadvantage that at light loads the composite engine would be less economical than the gas engine alone. The problem is a very complex one, however, and cannot be profitably discussed offhand.

Construction of Small Dynamos and Motors.

The discussion of what might be termed "professional designing," that is, the design of machinery and apparatus from the standpoint of those who are regularly engaged in that class of work, is outside the avowed scope of this journal, and we therefore do not print articles of that character. But on account of the receipt of an almost continuous stream of letters from readers asking for instructions as to the modification of some design which we have published, or requesting aid in the design and construction of some dynamo or motor for which we have never published a design, we have decided to present a series of articles containing complete data and instructions from which any one familiar with the simple fundamentals of dynamo and motor construction may be able to lay out a direct-current machine of any size up to 16 inches armature diameter. This series of articles begins in the present number, on the next following page, and will doubtless run through eight or ten issues. As we find it impracticable to carry in stock back numbers more than a few months old, we suggest in this connection that those of our readers who are interested in this class of work will find it advisable to preserve the numbers of the paper in which these articles appear.

As stated in the introductory paragraphs of the first article of this series, it is impossible to lay down rules and formulas and to prepare accompanying tables which will enable an amateur designer to turn out a dynamo or motor that shall run sparkless, be reliable and reasonably efficient, and at the same time cost the minimum amount of money per unit of output. Since the question of specific cost is of much less importance in amateur construction than smoothness and reliability of operation, the articles have been based on a generous margin of sparklessness and ample radiating surfaces and insulation. After covering the fundamental features of "laying out" a design, the articles will deal specifically with different types of field magnet, classes of armature winding, etc., and will also include the modification of a given design to adapt it to voltages or services different from those for which it was originally intended. In short, it is hoped that these articles will enable a skilled electrical worker to go just as far in the design, construction or modification of small direct-current machines as it is possible to go without having complete knowledge of the scientific principles of dynamo design and extensive experience in the application of them.

DESIGN AND CONSTRUCTION OF SMALL DYNAMOS AND MOTORS.

BY CECIL P. POOLE.

The object of this series of articles is to enable amateurs and students to plan and build any size of direct-current dynamo or motor from 3 inches to 16 inches armature diameter without the necessity of mastering the science of dynamo design. In order to do this, the scope of the articles will necessarily be limited to machines of conventional types and characteristics. The reader need only follow the instructions given to produce a machine which will work sparklessly at normal loads with fixed brushes.

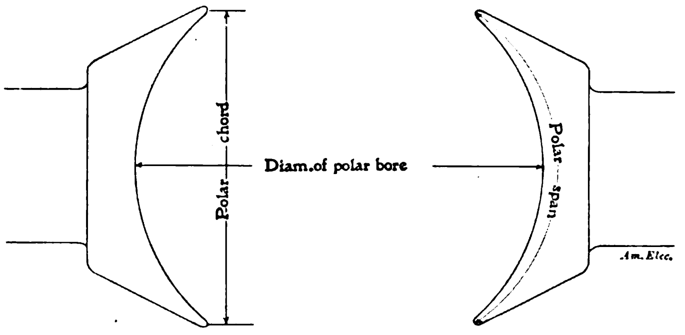

FIG. 1.

In treating the subject in such a systematic and arbitrary manner it is out of the question to insure that all of the machines built according to the rules given will show maximum output per pound of material or per dollar of cost; no hard-and-fast rules can be formulated by means of which any such results can be attained by an inexperienced builder.

The starting point in laying out a direct-current machine is the armature diameter, and by the method here employed this depends on the output of the machine and its speed. If the builder desires to obtain any particular speed, the diameter of the pole-face bore (see Fig. 1) may be estimated at the start by means of the formula

$$A = 100 \times \mathit{watts} \div \mathit{r.p.m.} \times K \qquad (1\text{-}a)$$

and the first two columns of Table III. The value of K depends on the number of poles, and is given in Table II. The watts are the product of total armature current and total armature e.m.f.; for a dynamo the watts may be taken as equal to 1.1 × the watts delivered to the external circuit at full load. For a motor, the watts may be taken directly from Table I.

TABLE I.—Motor Armature Current and Watts.

		Armature Current per wire at Different Voltages.			
H.P.	Armature watts.	110 V.	220 V.	250 V.	500 V.
¼	310	1.8	0.9	0.62	0.31
½	572	2.6	1.3	1.15	0.55
¾	790	3.6	1.8	1.6	0.79
1	990	4.5	2.25	2.	0.99
1½	1430	6.5	3.25	2.86	1.43
2	1870	8.5	4.25	3.75	1.87
3	2730	12.4	6.2	5.46	2.73
4	3575	16.25	8.13	7.15	3.58
5	4400	20.	10.	8.8	4.4
6	5215	23.7	11.85	10.43	5.22
8	6860	31.	15.5	13.74	6.87
10	8360	38.	19.	16.72	8.36
12½	10340	47.	23.5	20.7	10.35
15	12540	114 ÷ p*	28.5	25.1	12.55
20	16500	150 ÷ p*	37.5	33.	16.5

*p = number of field magnet poles.

Having found the value of A by the above formula, the diameter of the pole-face bore will be found in the first column of Table III in line with the number in the second column corresponding with the result of the formula; if there is no number in column A exactly equal to the calculated value of A, take the next larger number, and start with the polar bore corresponding to it.

TABLE II.—Values of K.

No. of field magnet poles =	2	4	6
Value of K =............	0.89	0.5225	0.3584

If no particular speed is required, the speeds given in the right-hand column of Table III will be found well adapted to ordinary service. When these speeds are used, the formula for ascertaining the polar bore is reduced to

$$B = \mathit{watts} \div 64 \times K \qquad (1\text{-}b)$$

In words, multiply K by 64 and divide the watts by the result. Having found the value of B, the polar bore is determined from Table III in the same way as before, except that the values of B are in the third column. It should be remembered that when the calculated value of A or B is not in the table, the nearest *larger* value should always be used to locate the polar bore, never the nearest smaller number.

The next step is to start on the winding. In the fourth column of Table III are numbers which are the products of the number of wires all around the armature periphery and the current in each wire. For convenience these values are called "ampere-wires." The values in the table are the greatest allowable number of ampere-wires for each diameter of pole-face bore and must not be exceeded appreciably; a small excess, such as one or two per cent, is allowable in cases where it would prevent relaying out a design. Dividing the ampere-wires by the amperes per wire obviously gives the total number of wires allowable.

Rule I.—For 110-volt dynamos of 10 kilowatts and under, and for all machines of higher voltages, the current per wire is one-half the delivered current × 1.05; for 110-volt machines of more than 10 kilowatts the current per wire is equal to 1.05 × delivered current ÷ number of magnet poles.

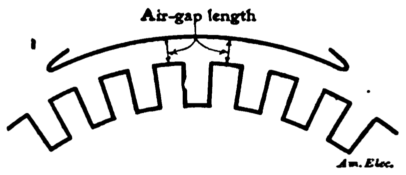

FIG. 2.

TABLE III.—General Data.

Diam. polar bore.	A	B	Wires × amperes per wire.	Length of air gap (Fig. 2).			
				2 poles.	4 poles.	6 poles.	R.P.M.
3	35.54	15.59	2,458	1/16	..	..	2800
3⅛	40.58	17.26	2,472	1/16	..	..	2725
3¼	46.09	19.04	3,108	5/64	..	..	2645
3⅜	52.11	20.93	3,126	5/64	..	..	2570
3½	58.65	22.92	3,772	3/32	..	..	2510
3⅝	65.93	25.02	3,792	3/32	..	..	2435
3¾	73.39	27.23	4,448	7/64	..	..	2375
3⅞	81.64	29.56	4,470	7/64	..	..	2320
4	90.51	32.	5,132	⅛	1/16	..	2265
4⅛	100.	34.56	5,754	⅛	1/16	..	2210
4¼	110.	37.24	5,180	⅛	1/16	..	2160
4⅜	121.1	40.04	5,200	⅛	1/16	..	2115
4½	132.7	42.96	5,222	⅛	1/16	..	2070
4⅝	145.1	46.	5,244	⅛	1/16	..	2030
4¾	158.2	49.18	5,266	⅛	1/16	..	1990
4⅞	172.2	52.47	5,286	⅛	1/16	..	1950
5	186.9	55.9	6,632	5/32	5/64	..	1915
5¼	219.1	63.16	6,682	5/32	5/64	..	1845
5½	254.8	70.94	6,730	5/32	5/64	..	1780
5¾	294.4	79.28	6,774	5/32	5/64	..	1725
6	338.1	88.18	6,816	5/32	5/64	3/64	1670
6¼	386.	97.66	6,860	..	5/64	3/64	1620
6¾	438.5	107.7	6,900	..	5/64	3/64	1570
6⅛	495.7	118.4	6,940	..	5/64	3/64	1530
7	557.9	129.7	8,372	..	3/32	1/16	1485
7¼	625.3	141.5	8,416	..	3/32	1/16	1450
7½	698.2	154.1	8,460	..	3/32	1/16	1420
7¾	776.7	167.2	8,502	..	3/32	1/16	1375
8	861.1	181.	8,542	..	3/32	1/16	1345
8¼	951.7	195.5	8,582	..	3/32	1/16	1315
8½	1049.	210.7	10,054	..	7/64	5/64	1285
8¾	1152.	226.5	10,100	..	7/64	5/64	1260
9	1263.	243.	10,142	..	7/64	5/64	1230
9¼	1380.	260.2	10,210	..	7/64	5/64	1205
9½	1505.	278.2	10,224	..	7/64	5/64	1185
9¾	1638.	296.8	10,264	..	7/64	5/64	1160
10	1778.	316.2	11,774	..	⅛	5/64	1140
10¼	1927.	336.4	11,820	..	⅛	5/64	1120
10½	2079.	357.3	11,860	..	⅛	5/64	1100
10¾	2250.	378.9	11,904	..	⅛	5/64	1080
11	2424.	401.3	11,944	..	⅛	5/64	1060
11¼	2608.	424.5	11.984	..	⅛	5/64	1040
11½	2801.	448.5	13,520	..	9/64	3/32	1025
11¾	3004.	473.3	13,574	..	9/64	3/32	1010
12	3216.	458.8	13,614	..	9/64	3/32	995
11¼	2608.	424.5	11,984	..	⅛	5/64	1040
12¼	3439.	525.2	13,660	..	9/64	3/32	980
12½	3673.	552.4	13,694	..	9/64	3/32	960
12¾	3917.	580.5	13,740	..	9/64	3/32	950
13	4172.	609.4	15,310	..	5/32	7/64	935
13¼	4438.	639.1	15,354	..	5/32	7/64	920
13½	4716.	669.6	15,400	..	5/32	7/64	910
13¾	5006.	701.1	15,440	..	5/32	7/64	895
14	5308.	733.4	15,480	..	5/32	7/64	885
14¼	5622.	766.6	15,520	..	5/32	7/64	870
14½	5949.	800.6	15,564	..	5/32	7/64	860
14¾	6289.	835.6	15,604	..	5/32	7/64	850
15	6642.	871.4	18,774	..	3/16	⅛	840
15¼	7009.	908.2	18,820	..	3/16	⅛	830
15½	7389.	945.9	18,864	..	3/16	⅛	820
15¾	7783.	984.5	18,970	..	3/16	⅛	810
16	8192.	1024.	18,954	..	3/16	⅛	800

(This rule applies to the fundamental method on which this article is based; it is not necessarily true of dynamos in general.)

This series of articles is based on the use of slotted armature cores, and the following rules must be followed in order to obtain satisfactory results:

Rule II.—The width of an armature coil slot must not exceed three times the length of the air-gap; if possible, it should be kept within twice the air-gap length.

Rule III.—The depth of a coil slot must not exceed six times its width; if possible, it should be kept within four times its width.

Rule IV.—The air-gap length must not be less than the value given in Table III opposite the diameter of polar bore and under the proper number of magnet poles.

Rule V.—The sum of the widths of all the armature teeth, measured at the narrowest part, must be practically equal to the diameter of the polar bore.

Before proceeding farther, it may be advantageous to illustrate the application of the formulas, tables and rules thus far given. Suppose it is desired to build a 220-volt, 5-h.p. motor, to run at 1000 r.p.m., the number of field magnet poles to be four. From Table I, the number of watts is 4400; from Table II, $K = 0.5225$. Substituting these figures in formula (1-*a*) we have

$$A = 100 \times 4440 \div 1000 \times 0.5225;$$

hence, $A = 842$ and a fraction. The nearest larger number in column 2 of Table III is 861.1 and the corresponding polar bore is 8 inches. From column 4, the maximum number of ampere-wires is 8540, and from Table I the current per wire is 10 amperes; the maximum allowable number of wires, therefore, is 854.

TABLE IV.—Current-carrying Capacity of Round Armature Wires. B. & S. Gauge.

Wire size.	At Table III speeds.	At lower speeds.
8	40	34
9	32	27
10	25.6	21.7
11	20	17
12	16	13.6
13	12.8	10.9
14	10	8.5
15	8	6.8
16	6.5	5.5
17	5.1	4.3
18	4.1	3.5
19	3.3	2.8
20	2.6	2.2
21	2.1	1.78
22	1.7	1.45
23	1.35	1.15
24	1.1	0.93
25	0.9	0.76
26	0.7	0.59
27	0.56	0.47
28	0.46	0.39
29	0.36	0.31
30	0.29	0.25

From Table IV, the size of wire necessary to carry 10 amperes at speeds less than those in Table III is No. 13.

From column 6 of Table III, the air-gap is 3-32 inch, and according to Rule II, the width of the armature coil slots must not exceed 9-32 inch. From the left-hand section of Table V, the nearest slot width for No. 13 wire is 0.21 inch, which takes one wire only. The slot depth, according to Rule III, must not exceed 6 × 0.21 = 1.26 inches; the nearest slot depth in the right-hand section of Table V for No. 13 wire is 1 9-32 inches, which will take 12 wires.

The number of wires required is 854, as just stated. Each slot will take 12 wires (1 wide x 12 deep), and the slots must all contain the same number of wires each; therefore it is not practicable to use exactly 854 wires. The nearest practical number is 852 wires, which will occupy 71 slots.

The polar bore being 8 inches and the air-gap 3-32 inch, the armature core will be 8 — 3-16 = 7 13-16 inches. The slots being 1 9-32 inches deep, the diameter of a circle drawn through the narrowest part of the teeth will be 7 13-16 — 2 9-16 = 5¼ ins. The circumference of this circle is 16.49 inches, and of this circumference the slots occupy 71 × 0.21 = 14.91 inches; this leaves only 16.49 — 14.91 = 1.58 inches for all the teeth, which is manifestly absurd, even without considering Rule V. It here becomes evident that the armature may have to be increased in diameter, which may increase the air-gap. The method of making this correction will be explained in the next article.

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AN INCONSISTENCY IN THE NATIONAL ELECTRICAL CODE.

BY C. R. JAMES.

The National Underwriters' Electrical Code has much to say about the construction of lamp sockets and goes into many details. It seems strange that the committees which have formulated this code should have given so much attention to the socket itself and utterly ignored a defect which is common to the great majority of Edison sockets. This defect is that the brass shell of the Edison lamp base usually is not by any means entirely protected by the lamp socket, with the result that a part of the lamp base which is especially liable to be brought in contact with persons and grounds is exposed without any protection whatever. The accompanying photograph of an Edison socket with lamp illustrates this point. This lamp and socket are not by any means exceptional, as both are of standard markes now on the market, hundreds of thousands of which are now in use. The live lamp base is exposed for a distance of about 3-16 of an inch. The majority of electrical engineers seem never to have noticed this detail, but they would have done so quickly had they received shocks in attempting to turn on a drop light in a damp basement with the exposed part of the lamp base on the non-grounded side of the circuit. The exposure of live metal is sufficient on the socket shown, so that it is not only possible, but quite probable, that any one taking firm hold of the socket would make contact with it. Of course, the voltage on an ordinary lamp socket is not dangerous to the average person, but it is far from being pleasant to receive a shock even from such a low voltage, and further than this, there is danger that fires may be caused by the live lamp base coming in contact with some grounded conductor. In view of the great precautions that are taken to prevent defective lamp sockets from causing fires, it looks decidedly absurd to "strain at a gnat" in the socket itself and "swallow a camel" in the lamp base which is screwed into the socket. One would think that the Edison lamp base had been in use enough years so that little defects of this kind would have been weeded out. All that is necessary is either a lengthening of the socket shell and lining or a shortening of the lamp base.

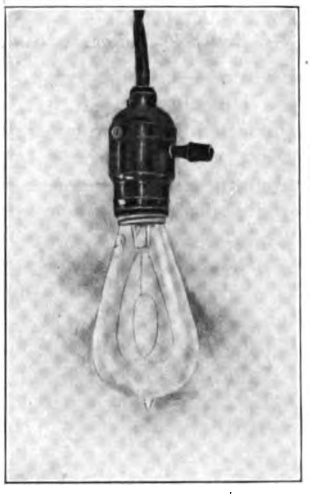

FIG. 1.—EDISON SOCKET AND LAMP.

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SELECTIVE RINGING SYSTEMS.

The Kellogg Harmonic System.

BY A. DALLAM O'BRIEN.

The question as to the advisability of the use of party lines in telephone central offices may at the present stage in telephone development be considered as being fairly settled. Subscribers whose use of the telephone is small demand service at a low cost and it is to this class of customers that the party line particularly applies. The objections that may be offered to this class of service on the part of the subscriber are all insignificant compared to the annoyance due to signal ringing and the consequent necessity of being on the alert whenever the telephone rings; in addition to this there is a most decided temptation to listen to conversations which may originate from another station on the line. After a

TABLE V.—Slot Dimensions for Standard Sizes of Round Armature Wires, Double Cotton Insulation.

Wire sizes.	Slot width. No. of wires side by side 1	2	3	4	5	Wire sizes.	Slot depth. Total number of wires, depthwise of slot: 4	6	8	10	12	14	16	18	20	Wire sizes.
8	.27	..	..	..	..	8	3/4	1 1/32	1 5/16							8
9	.25	..	..	..	..	9	11/16	15/16	1 3/16							9
10	.24	.35	..	..	..	10	5/8	7/8	1 1/16							10
11	.23	.33	..	..	..	11	19/32	25/32	1							11
12	.22	.31	..	..	..	12	9/16	3/4	15/16	1 3/32	1 9/32					12
13	.21	.29	.37	..	..	13	1/2	11/16	27/32	1	1 5/32					13
14	.20	.28	.35	..	..	14	..	5/8	25/32	15/16	1 1/16	1 7/32	1 3/8	1 1/2		14
15	..	.26	.33	..	..	15	..	9/16	11/16	27/32	1	1 1/8	1 1/4	1 3/8	1 1/2	15
16	..	.25	.31	.37	..	16	..	..	21/32	25/32	29/32	1 1/32	1 3/16	1 5/16	1 7/16	16
17	..	.24	.29	.34	..	17	..	..	5/8	23/32	27/32	15/16	1 1/16	1 3/16	1 1/4	17
18	..	.23	.28	.33	..	18	..	..	9/16	11/16	25/32	7/8	31/32	1 1/16	1 3/16	18
19	..	.22	.26	.31	..	19	..	..	..	5/8	23/32	13/16	29/32	1	1 1/16	19
20	..	.21	.25	.29	.33	20	..	..	..	19/32	21/32	3/4	27/32	15/16	1	20
21	..	.20	.24	.28	.31	21	..	..	..	9/16	5/8	23/32	25/32	7/8	15/16	21
22	..	..	.23	.26	.30	22	..	..	..	17/32	19/32	21/32	3/4	13/16	7/8	22

thorough trial of signal ringing systems, it has become very thoroughly realized that the successful party line system—successful because it satisfies the users—is the selective arrangement in which only the station desired is called and in which there is no intimation to the other stations on the line that a call is being made.

There are in use at the present time a large number of selective systems. In some of these the step-by-step method is employed; others use currents of different strengths and polarities to actuate specially polarized bells, and in a system recently described in this paper the use of properly designed resonance circuits, with a combination of an inductance and a capacity, render the connected bells susceptible only to a predetermined current frequency.

It is the purpose of the present article to describe the Kellogg selective system adapted for use with four party lines or lines having less than four stations connected to them. The selective feature depends upon the harmonic vibration of a reed or rod when actuated by an alternating current whose frequency corresponds with the frequency of the vibration of the rod in question. The principle of operation is so thoroughly known and understood that it is not necessary to explain it at length. In the operation of the selective system under consideration alternating currents having the following frequencies are employed: 2000, 4000, 6000 and 8000 alternations per minute, the current being furnished as later described.

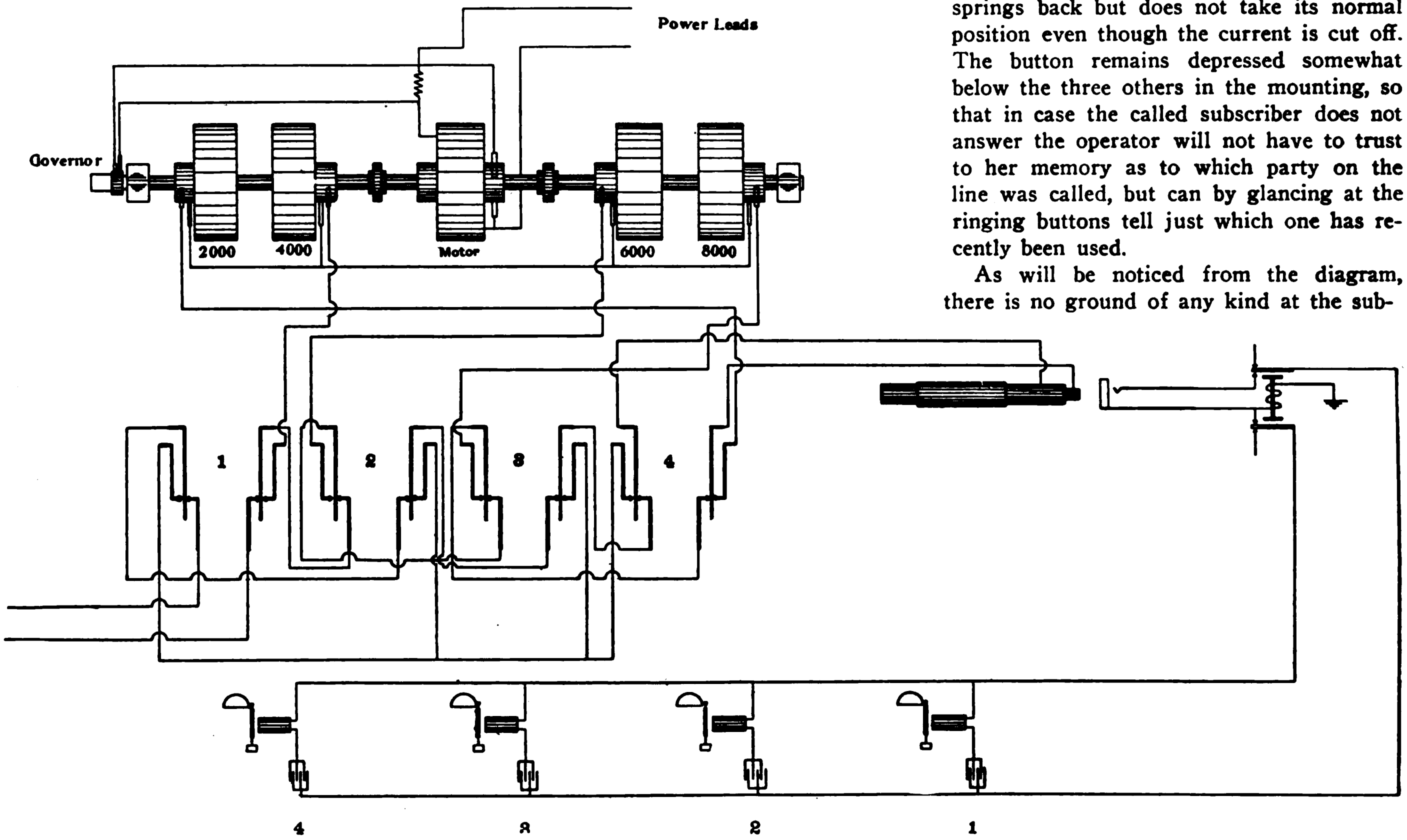

FIG. I.—GENERAL ARRANGEMENT OF CIRCUITS IN KELLOGG SELECTIVE RINGING SYSTEM.

The ringers or bells at the sub-stations differ only in the size of the tapper and the length of the tapper arm. The bells are solidly constructed and are strongly polarized by means of a powerful permanent magnet, which with the bell coils and the armature are mounted on a brass and iron frame, the tapper being suspended from the lower end of the armature by a flexible steel spring. Each bell is equipped with a single gong so fastened to the mounting that it may be adjusted for the different size tappers. The general arrangement of the circuits and equipment is shown diagrammatically in Fig. 1. In the central office is located the multicycle ringing set which consists of four generators mounted on the same shaft with a direct-current motor, the generators having respectively two, four, six and eight poles, and as the motor runs at a speed of 1000 revolutions per minute the generators furnish currents at frequencies of 2000, 4000, 6000 and 8000 alternations per minute. The size of the generators in the ringing set depends upon the size of the central office and the consequent demand for ringing current. As will be noted from the diagram, one side of each of the ringing machines is grounded.

The selective ringing buttons are arranged four in one mounting and are placed in the keyboard in the usual way, so that the answering cord of each cord circuit is connected through all four of the keys. The arrangement of the keys as they are usually wired is shown in the diagram, the keys being numbered 1, 2, 3 and 4 to correspond with the numbers of the sub-stations. The outside or ringing springs of one side of all four keys are connected together, the common connecting wire being grounded. The other ringing spring on each key is connected to a lead from one of the machines; the usual arrangement being to connect No. 1 to the machine which furnishes current at 4000 alternations per minute, No. 2 to the 6000-alternation current, No. 3 to the 8000-alternation current, and No. 4 to the 2000-alternation machine. The sub-stations may be connected to the line in any order, not necessarily as shown in the diagram, the only essential being that the bells are bridged across the line in series with a condenser in each case. As previously stated, the one point of difference between the bells at the different stations lies in the size of the tapper and the length of the spring which connects the tapper to the armature. As might be expected, the length of the spring and the size of the tapper reach their maximum with party No. 4, where the frequency of the ringing current is 2000 alternations per minute, and their minimum with party No. 3, where the ringing current has 8000 alternations.

In the operation of this system, when it is desired to call a certain station on a party line, the calling plug is inserted in the jack of the desired line and the button corresponding to the station to be called is depressed. As long as the operator holds the ringing button in a depressed position, ringing current will continue to flow over the line and signal the desired station. Upon releasing the ringing button, it springs back but does not take its normal position even though the current is cut off. The button remains depressed somewhat below the three others in the mounting, so that in case the called subscriber does not answer the operator will not have to trust to her memory as to which party on the line was called, but can by glancing at the ringing buttons tell just which one has recently been used.

As will be noticed from the diagram, there is no ground of any kind at the sub-station, the ringing current returning to the office over a metallic circuit and finding its ground at the office itself. In order to further identify the buttons of the four-party key, they are colored black, green, red and blue, so that after a short time the significance of the different colors is at once apparent to the operator. Where the party lines connected to the central office form a considerable portion of the total number of connected lines, the question of equipping each cord circuit with a selective key is one that is not likely to arise. There are, however, numerous instances in practice where the party lines form only a small portion of the exchange equipment, and in these cases it becomes a question as to the policy of equipping all the cord circuits with selective keys. From a purely operating standpoint, there can be no question but that the better practice would be to use the selective equipment throughout, but owing to the increased cost of these keys over the ordinary type, the selective ringing is often accomplished by using the ordinary key on all the cord circuits and equipping each operator's position with a master key in addition. The master key is in reality a quadruple throw switch, through which the ringing strap is connected to the keys in the keyboard. The contact points of the master key, or switch, are connected to leads from the generators which furnish the different frequency currents, and by the operation of this key current of any desired frequency may be connected to the ringing keys in the keyboard. It is, of course, evident that with this method the operation of ringing a party line involves two operations on the part of the switchboard operator, and that in consequence the operator's efficiency or the number of calls which she can complete in a given time is decreased. From this, it will be evident that whenever the conditions do not absolutely prohibit the use of a complete equipment of selective keys, it is by all means desirable to use them, as the operator's efficiency is a very large factor in the successful operation of a telephone plant. It is not necessary with this system to provide a separate ringing machine for furnishing the signalling current for ringing the individual lines, as the 4000-alternation current will answer perfectly for this purpose, and consequently, the No. 1 key can be used for ringing on all the direct lines. It is, of course, of the greatest importance in a system of this kind, which depends for its successful operation upon the harmonic vibration of the tappers, that the frequency of the current should remain practically constant. As this system is ordinarily used, the four generators are mounted on the same shaft with a motor to which current is furnished from some outside source. The average commercial power circuit is subject to more or less variation in voltage, and consequently, in order to keep the speed of the motor constant it is absolutely necessary to provide a governor which will compensate for the voltage variations in the circuit.

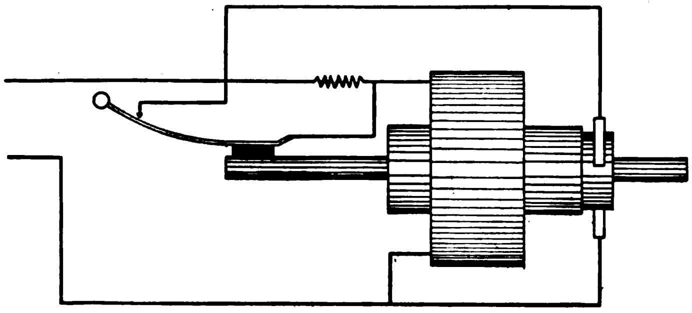

FIG. 2.—MOTOR-SPEED GOVERNOR.

With this system a governor has been designed to control the speed of the motor, and a test made on this apparatus has proven its ability to regulate the speed of the motor within 2 per cent of the normal, while the line voltage varies through a range of from 20 per cent above to 20 per cent below the normal voltage. The general features of this governor and the principle upon which it operates are shown in the diagram of Fig. 2. On the end of the ringing shaft is attached a spring carrying a weight which is so arranged as to be thrown outward by centrifugal force and open and close a shunt circuit around a resistance in series with the field coils of the motor. As is well known, the introduction of a resistance in the field circuit results in decreasing the strength of the field and increasing the speed of the motor, while in this particular case it is desired to keep the speed of the motor constant at 1000 revolutions per minute.

When the ringing set is installed, the maximum variation in the voltage of the power circuit is determined and the motor designed so as to run at a speed below the normal when the resistance is cut out of circuit and when the voltage of the power circuit is at its maximum, and to run above normal speed when the power circuit obtains its minimum voltage and the resistance is cut into the field circuit. This being effected, the governor is adjusted so that the motor will run at its normal speed of 1000 revolutions at the normal voltage on which it is intended to operate. It will be apparent that as the voltage of the power circuit varies, thus causing the speed of the motor to rise and fall, the resistance in the field circuit will be cut in or out with a result that the speed of the motor will remain practically constant and the harmonic action of the system preserved.

For use in small exchanges, where the expense of a ringing set such as that described would render it prohibitive, a rotary pole changer has been designed to answer satisfactorily the selective requirements. This pole changer consists of a motor directly coupled to a direct-current generator, the set being equipped with the same type of governor as that used with the regular equipment. The current from the generator is led by means of two slip-rings to four commutators which serve to interrupt it at the four desired frequencies.

To adapt this system to a switchboard which is already in service is a comparatively simple matter and necessitates but small changes in the central office equipment. A multiple ringing set must, of course, be installed and the ringing and listening keys replaced by selective keys, or each position equipped with a master key. In addition to this, slight changes must be made in the wiring of the keyboard and ringing leads from each of the four machines brought to each position. The absence of all parts which may be continually in need of adjustment renders the system one easily maintained and one not liable to constant troubles. That the system is not in the experimental stage is attested by the fact of its use in exchanges serving upwards of 50,000 subscribers.

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PRACTICAL MANAGEMENT OF ROTARY CONVERTERS.

BY F. P. DE WILDE.

The rotary converter is the connecting link between the direct-current and alternating-current systems. It combines in the armature and field windings of a single machine the functions of two machines—the motor-generator. It may be regarded as a synchronous motor driving a direct-current generator, or it may be inverted and used as a direct-current motor driving an alternating-current generator. The ratio between the alternating and direct-current voltages of a rotary converter depends upon the number of phases, the wave form of its alternating current, and the field excitation of the converter. With a sine wave alternating supply the ratios of conversion are approximately as follows: Single phase, 0.71; two phase, 0.71; three phase, 0.61; six phase, 0.71, with the star connection, or 0.61 with the double delta connection.

There are two general methods employed in starting rotary converters; one is by the use of an auxiliary alternating-current starting motor and the other by starting the machine as a plain shunt-wound motor, using a short-circuiting switch on the series field winding if the machine happens to be compound-wound. In following the former method (Fig. 1), see that the alternating-current and direct-current brushes are all

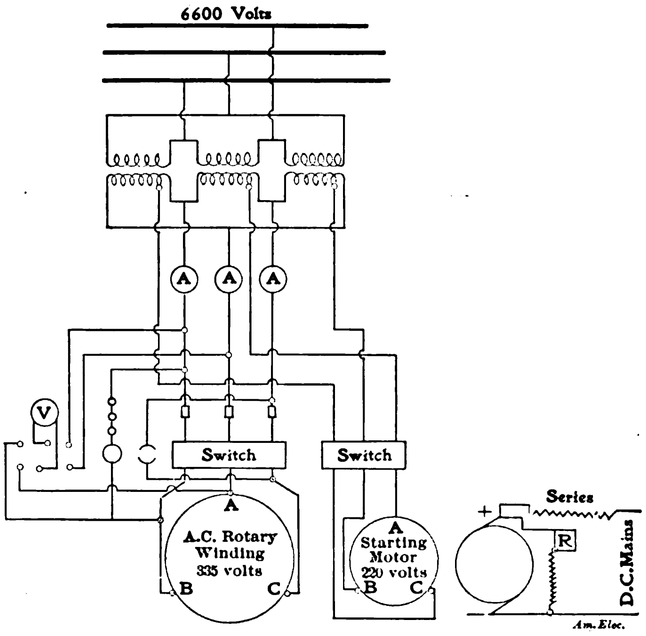

FIG. 1.

in their correct position; next, see that all switches are open on both the alternating-current and direct-current sides and that the resistance of the rheostat is all cut in the field circuit. Then close the alternating-current main circuit-breakers and see that the plugs to the synchronizing lamps, or synchronoscope, are in and that the lamps burn dimly, also that the plug for the direct-current voltmeter is in. Start the rotary by closing the starting motor switch and build up the direct-current voltage by cutting out resistance in the rheostat until the voltage is equal to the bus-bar voltage. Now move the main alternating-current switch blades to within an inch or so of the jaws, so that they may be thrown in more quickly at the proper moment. Now note the lamps or synchroscope and adjust the speed by means of the field rheostat until the lamp dims slowly and regularly. It may be necessary to shift the direct-current brushes back from the neutral point in order to get the proper speed. When the lamps show pulsations at the rate of about one every ten seconds the switch should be closed quickly, and this should be done when the lamps are getting dark rather than when they are receding from synchronism. Now open the starting motor switch and adjust the converter field excitation so as to get minimum current in the alternating-current ammeters. Next close the direct-current circuit-breaker and switches, and see that the brushes are in the proper position.

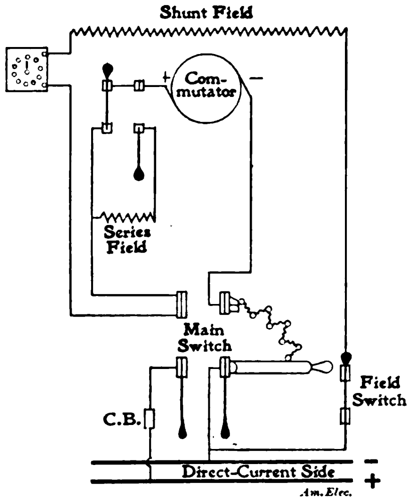

FIG. 2.

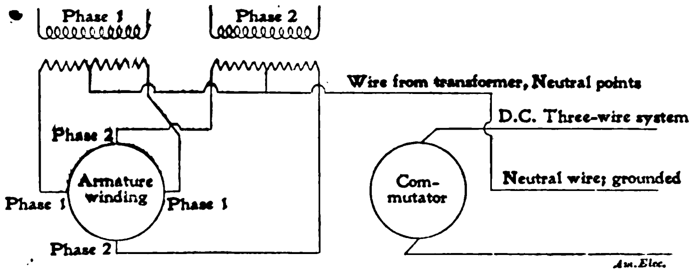

FIG. 3.

To start a single converter from the direct-current side, first see that all switches are open, that the direct-current brushes are all properly set, and that the series field is cut out or short-circuited. Next close the alternating-current circuit-breaker and positive switch. Close the field switch with all the rheostat resistance cut out, and try the field poles to see that they are magnetized. Now start the converter as a direct-current motor by cutting out the starting resistance slowly; when this is all cut out close the negative switch. Then adjust the speed to synchronism by means of the field rheostat and the synchronizing lamps. It is also necessary to have the alternating-current voltage of the rotary converter equal to that of the alternating-current supply; shifting the brushes will assist to a slight extent in making this adjustment. When the voltage is correct and the lamps indicate the proper phase relations, close the alternating-current switches. Now adjust the rheostat for minimum alternating current and set the direct-current brushes at a non-sparking position. In the foregoing it is assumed that the circuit-breaker is on the positive side and the starting resistance across the terminals of the negative switch, as indicated in Fig. 2.

In starting a second converter to be run in parallel with another, the same method is used as in starting a single converter, using the synchronizing and voltmeter plugs on the panel of the converter to be started. In addition, however, care must be taken in building up the direct-current voltage to make sure that the machine being thrown in builds up in the same direction as that of the other rotaries and that the brush-holders are in similar positions. Next, synchronize, as already explained, and after having thrown the machine in, open the starting switch. In paralleling the direct-current side, it is better to close the switches when the load on the running converter is minimum. If the load on a converter having a strong series field winding is constant and heavy, it is better to short-circuit or cut out the series windings on both machines while throwing them together on the direct-current side; otherwise the sudden division of the load will cause a rush of current between the machines which will be very likely to result in the reversal of the polarity of the first converter. Now regulate the alternating current by means of both rheostats to obtain the minimum current. The division of the load between the converters may be regulated to a slight extent by shifting the direct-current brushes. This method of paralleling is also used where the starting motor method of bringing the machines in synchronism is used.

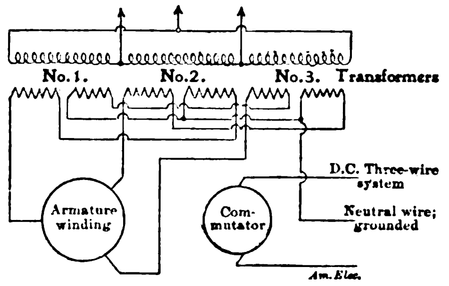

FIG. 4.

It will sometimes happen that a machine is reversed. This can easily be rectified by recharging the field magnet. Cut in all the resistance in the field circuit, disconnect the field winding from the brushes and excite it in the right direction from another source, such as the other operating machines. It is assumed that the main direct-current switch is left open.

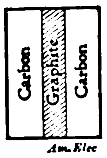

FIG. 5.

It will sometimes happen that only one alternating-current circuit-breaker comes out. If the machine stays in step, pull out the switch corresponding to this leg, throw in the circuit-breaker and watch the ammeter in this leg; now throw in the switch to see if this leg is working. If the alternating-current circuit-breakers come out and the machine falls out of synchronism, open the direct-current circuit-breaker and all switches immediately. Some rotaries are provided with tripping coils on the circuit-breakers which open the breakers and prevent the rotaries from racing at this point. The tripping coils are usually energized by means of a little centrifugal governor on the end of the converter shaft which closes the circuit at a certain speed. Without such a precaution, if two or more converters were run in parallel on the direct-current side and one should fall out of step on the alternating-current side, the other machines would commence to feed this one and drive it as a motor at a dangerous speed.

Flashing may be due to any one of several causes, such as overloading or the failure of the alternating-current supply circuit; it may also occur by reason of several converters operating on the same transformer bank. When this method is used, it is sometimes impossible to operate the machines without undue sparking and blackening of commutators due to the exchange of heavy currents between the direct-current sides. This can be mitigated to a great extent by providing for each converter a separate set of transformer secondary windings, all in one bank of transformers.

One of the most prolific causes of flashing is the failure of the alternating-current voltage across the collector rings. This sets up an abnormal voltage between the positive and negative brush-holders, which will make itself known by short-circuiting the commutators, blistering the brush-holder boxes, and dropping hot metal on the commutators which causes the coils to burn out almost every time this occurs. The writer advocates setting the brush boxes farther away from the commutator than usual, so as to reduce this tendency, but the only complete remedy is to connect the neutral points of all the transformer secondaries together and to ground, as shown in Figs. 3 and 4. This arrangement is often used on rotary converters for three-wire direct-current service, and is a most effective remedy for the trouble just mentioned. The writer has known cases in which the commutator had to be turned off about once every sixty days. The machine, a 60-cycle rotary, would get flat spots and the brushes run red-hot at times when the machine was only carrying normal load; pure carbon brushes were used on the commutator, the armature was correctly centered, the brushes correctly set, and all equi-potential points in the armature were connected together by cross connectors. The writer then took a hacksaw blade and cut narrow slits about 5-16 inch deep into the brush faces parallel to the mica in the commutator. The commutator was then put into good shape, and the slit brushes applied; the machines acted very differently and the commutators commenced to gloss up and gave very little trouble thereafter. I have always believed that nine-tenths of the commutator troubles are brought about through the commutator not being properly cared for. I have seen commutators that were actually corrugated, due to the bars wearing down faster than the mica. This trouble can be more or less avoided by sand-papering the commutator at regular intervals with very fine carborundum paper, and care should also be taken to see that the commutator has been properly tightened, which should be done after a long hot run, so that all the plastic material in the mica between segments will have softened and made it possible to take out the elasticity. If this is properly done there will be little tendency for the commutator to show high and low bars. Carbon brushes are made in a great many varieties of compositions, but the best brush the writer has ever used is a soft carbon brush with about 10 per cent. of graphite in it—just enough to make it self-lubricating. One large carbon company is now making a special brush with a strip of graphite about ⅛ inch thick built up in the brush as shown in Fig. 5. This brush is very satisfactory and the commutator requires practically no attention. The conductivity of the brush is good and it offers a high resistance to all local currents. The best results with any carbon brush are obtained with 30 to 35 amperes per square inch of face. The brush tension should never exceed 2 pounds per square inch; higher densities and pressures cause undue temperature rise at the commutators.

Hunting is a very troublesome factor, even to this day, with 60-cycle rotary converters. Various methods have been devised to overcome this trouble, such as using copper pole shoes which are embedded in one or more slots through the laminated pole-face and entirely surrounding the poles. This is usually effective, but not always. Another fairly effective method is to make the pole pieces of cast steel; these act as dampers and help commutation a great deal. Hunting usually manifests itself first on the rotary alternating-current ammeters, the needles of which will commence to swing backward and forward; then the brushes will give a peculiar squeak during the oscillations in speed; the alternating-current side of the rotary acts as a generator and a motor alternately. The distortion of the fields due to hunting results in "flashing," which can usually be stopped, however, by giving the machine a very stiff field, and a very effective damper has been found in the starting alternating-current motor which is simply thrown on the lines; or an idle induction motor is kept floating on the transformer secondaries.

The writer has always favored the use of a starting motor for bringing a rotary into step. Starting up from the direct-current side has several disadvantages; it requires a source of direct current by means of which the converter is started as a simple shunt-wound motor, and also requires a short-circuiting switch to cut out the series winding, if the converter happens to be a compound-wound machine, to prevent changes of speed being caused by changes in the armature current flow. The machine should also have switches by means of which the armature may be disconnected from the transformer secondaries; if the transformers are left connected, the armature winding will be more or less short-circuited by the secondaries of the transformers. A two-phase rotary can be in such a position as to require an enormous starting current; in fact the armature presents a short-circuit to the source of applied current and the alternating-current side must therefore be disconnected from the transformers in all two-phase rotaries. Even in three-phase rotaries this trouble is encountered, but to a less extent. A rotary converter transforming from direct current to alternating current has no constant speed, its speed being determined like that of a direct-current motor; the speed is therefore governed by the strength of the field and is consequently affected by the reaction of the armature current upon the field. The converter, therefore, will speed up excessively if a heavy induction load is thrown on the alternating-current side. This, however, may be overcome by exciting the converter from a generator the speed of which varies with that of the converter, particularly if the field of this generator is unsaturated at normal voltage. Then any change in speed of the rotary converter will cause a corresponding change in the exciting voltage, and strengthen the field of the rotary; its speed will then be independent of the amount or nature of the load. This method is used by the Westinghouse Company. To shut down a rotary converter operating in parallel on both sides, simply open the direct-current circuit-breaker and the direct-current switches; then open the alternating-current circuit-breaker and the alternating-current switches; cut in all the field rheostat and pull out synchronizing plugs. This applies to both methods of operating rotaries.

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THE THREE-WIRE GENERATOR.

BY GEORGE W. MALCOLM.

In my last article* it was stated, with a view to simplifying the elementary discussion, that all of the current returning to the generator by way of the neutral wire, when the load is unbalanced, passes first through one half and then through the other half of the balancing coil, dividing through both halves only when the e.m.f. delivered to the coil by the armature is zero, as indicated in Fig. 11. This is not strictly true. The arrows in Figs. 10 and 12 indicate accurately the direction of the e.m.f. delivered by the armature and that of the magnetizing current of the balancing coil, but not the flow of the neutral current.

When the load on the system is exactly balanced, no current flows in the neutral, of course. Then there flows in the balancing coil a small magnetizing and core-loss current supplied by the armature. The alternating magnetism in the core induces a counter e.m.f., just as in the case of the primary winding of a transformer on open secondary circuit. This e.m.f. is just enough lower than the armature e.m.f. to allow the exciting current to flow. Now, if the load be unbalanced, as indicated in the diagrams, the larger load being on the positive side of the system, the neutral current will tend to return to the negative brush of the dynamo through the then negative half of the balancing coil; when one-half of the current passes that way, however, it will have increased the magnetism of the core to such an extent as to increase the counter e.m.f. of the coil sufficiently to prevent any more current flowing in that half of the coil and to overcome the applied e.m.f. in the positive half just enough to allow the remainder of the neutral current to flow there. (The polarity of the coil being alternating, the terms positive and negative apply to that half which is positive or negative at the instant under discussion). Consequently, the neutral current divides with practical equality between the two halves of the balancing coil in all positions of the armature, the current in one-half of the coil exactly neutralizing that in the other half and leaving the core affected only by the exciting current supplied from the armature.

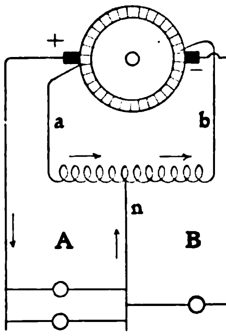

FIG. 10.

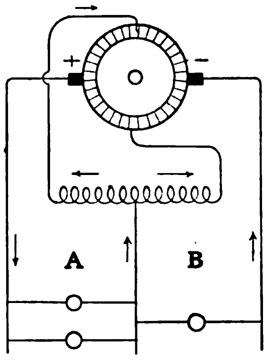

FIG. 11.

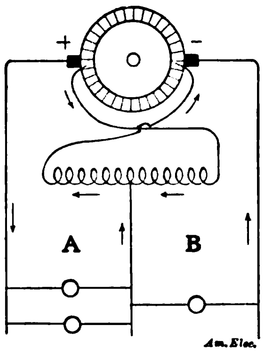

FIG. 12.

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*Page 470; September, 1904. Author's signature omitted by mistake.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.

The ninth annual convention of the International Association of Municipal Electricians was held at the Grand View Fraternal Hotel, St. Louis, September 13 and 14. After an executive session at 8:30 on the morning of the 13th the first regular meeting was called to order. In his opening address, President A. C. Farrand referred to the appropriate time and place of the meeting, in that they afforded opportunity to study the electrical exhibits at the Fair and to attend meetings of the International Electrical Congress. Mr. Walter M. Petty, chairman of the executive committee, reported that there was nothing requiring immediate attention. He did, however, speak of the need of making the name of the Association and its purposes better known. His remarks led to the appointment of a committee to advertise the Association.

The first paper presented for discussion was that of Mr. A. S. Hatch, of Detroit, on "Street Lighting." The methods of placing lamps as well as the different lamps employed were discussed. The ideal lighting system, Mr. Hatch said, was that of employing arc lamps on high towers. This gives even and well-distributed illumination.

The next paper presented was that of Mr. Adam Bosch, of Newark, N. J., the subject being "Limitations of the Telephone for Fire Alarm Purposes." The paper led to a spirited discussion. It was, however, the general opinion that the telephone should be used only as an auxiliary in reporting fires; that in case of fire, the fire alarm box should be pulled first and the telephone used, if necessary, afterward. The excited condition of the person telephoning, the similarity of the names of streets, and the indistinct pronunciation of the foreign element all tended to make the telephone more or less unreliable.

In the absence of Mr. William H. Thompson, of Richmond, Va., a paper prepared by him on "The Inspection of Theatres from an Electrical Standpoint" was read by the secretary, Mr. Frank P. Foster. Discussion of the paper was deferred to the next meeting, the Association adjourning until the following morning.

The session on Wednesday morning was taken up with the presentation and discussion of a paper by Mr. Walter M. Petty, of Rutherford, N. J., on "Methods of Testing." He went into a great many details as to the proper way of making periodic and systematic tests of fire alarm circuits, etc., and cited the practices adopted in various communities.

The election of officers for the ensuing year resulted as follow:

President, W. M. Petty, of Rutherford, N. J.; first vice-president, J. B. Yeakle, of Baltimore, Md.; second vice-president, G. H. Holderman, of Indianapolis, Ind.; third vice-president, C. E. Diehl, of Harrisburg, Pa.; fourth vice-president, Charles Greenwald, of New Brunswick, N. J.; treasurer, G. F. Macdonald, of Ottawa, Can.; secretary, F. P. Foster, of Corning, N. Y. Executive Committee: J. Murphy, Cleveland, Ohio; William Crane, Erie, Pa.; M. J. Donohue, Niagara Falls, N. Y.; A. S. Hatch, Detroit, Mich.; C. L. Williams, Laurel, Miss.; A. C. Farrand, Atlantic City, N. J.; W. H. Thompson, Richmond, Va.; F. C. Mason, Brooklyn, N. Y., and J. S. Craig, Toronto, Can. Finance Committee: W. H. Bradt, Troy, N. Y.; James Grant, New Haven, Conn.; T. C. O'Hearn, Cambridge, Mass., and J. D. Hall, Peoria, Ill.

It was voted to hold the next convention at Erie, Pa.

Lessons in Practical Electricity

TRANSFORMER CONNECTIONS.

Two or more transformers built to operate at the same potential and frequency may be connected together in a variety of ways; in fact, the primary and secondary terminals may each be considered exactly as the terminals of direct-current dynamos, with certain restrictions. The two principal precautions which must be observed in combining transformer terminals are that the terminals must have the same polarity at a given instant, and the transformers should have practically identical characteristics. The latter condition is not absolutely essential, but it is emphatically preferable. For example, if a transformer which has 2 per cent regulation be connected in parallel with one which has 3 per cent regulation, as indicated in Fig. 1, at no-load the transformers will give exactly the same e.m.f. at the secondary terminals, but at full load one will have a secondary e.m.f. of, say, 98 volts, while the other has an e.m.f. of 97 volts. The result is that the transformer giving only 97 volts will be subject to a back e.m.f. of one volt from its mate. This will not cause excessive current to flow backward through the secondary winding of the low-voltage transformer, but it will disturb the phase relations and lower the power-factor and efficiency of the combination; in such a case it is much better to work the secondary circuits of the two transformers separately.

In case the transformers have practically the same characteristics it is necessary, as stated above, to make sure that the secondary terminals connected together have the same polarity at a given instant; it is not necessary to find out definitely what the polarity is, merely that it is the same for both terminals. This can be easily done by connecting two of the terminals, as shown in Fig. 2, by a small strip of fuse wire, and then touching the other two terminals together. If the fuse blows then the connections must be reversed; if it does not, then they may be made permanent. It is seldom advantageous, however, to operate transformer secondaries in parallel; occasionally it may be necessary as a temporary expedient, but where the load is such as to require a greater capacity than that of a transformer already installed, it is much better to replace it by a larger transformer than to supplement it by an additional transformer of its own size.

All modern transformers have the secondary windings divided into at least two sections, which may be connected up either in parallel or in series. If the secondary e.m.f. of a transformer having two sections is 100 volts with the terminals in parallel, then connecting them in series will give 200 volts at the free secondary terminals, as indicated in Fig. 3. If the transformer be of the core type, and the two sections of secondary winding be wound on different limbs of the core, as in Fig. 4, it will be advisable, if the secondaries are to be operated in parallel, to make the connections ample and permanent, so that there will not be any liability to a difference between the current flowing in one secondary winding and that flowing through the other.

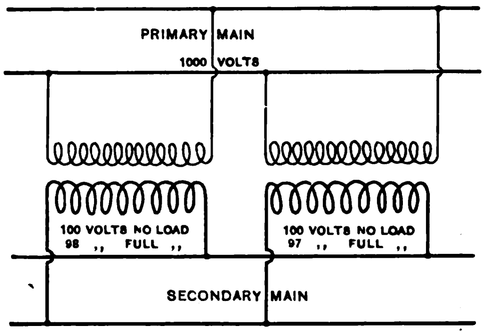


FIG. 1.—UNLIKE TRANSFORMERS IN PARALLEL.

Still referring to a transformer which has the two secondary sections on different legs of the core, if the secondary terminals are connected up to a three-wire distribution, as shown diagrammatically in Fig. 5, it is advisable to make the fuse, *Fc*, in the middle wire, considerably smaller than necessary to pass the normal load in either side of the circuit. The reason for this is as follows: Should the fuse, *Fa*, be blown, the secondary circuit through the section, *Sa*, will be open, and the corresponding half of the primary winding, *Pa*, will have a much higher impedance than the half of the primary winding, *Pb*, the inductance of which is so greatly neutralized by the load on the secondary winding, *Sb*, as explained in previous lessons. The result will be that the counter e.m.f. of the primary section, *Pa*, will be very much greater than

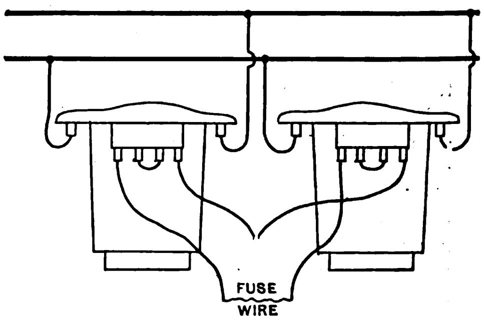


FIG. 2.—COMPARING INSTANTANEOUS POLARITY.

that of the section, *Pb*, and as the sections are in series the current must be the same through both halves of the winding; the drop or difference of potential, therefore, between the terminals of *Pa* will be much higher than that between the terminals of *Pb*, consequently the secondary voltage of *Sb* will be greatly lowered and the service impaired. As the primary winding, *Pa*, is designed to take only one-half of the total impressed e.m.f., the unbalancing referred to will subject it to a considerably higher e.m.f. than the normal value; consequently the magnetic density in that leg of the transformer core will be much higher than normal, and the transformer will heat disastrously.

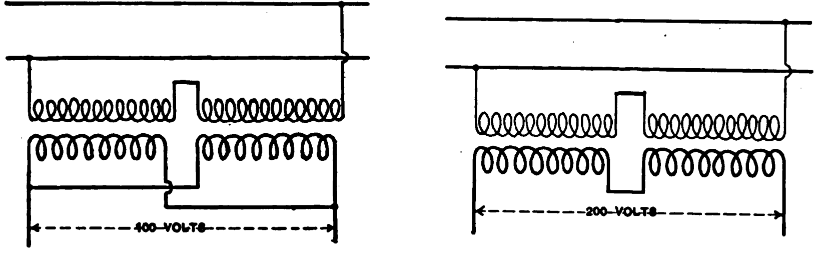


FIG. 3.—SECONDARY CONNECTIONS FOR DIFFERENT VOLTAGES.

If the fuse, *Fc*, in the middle wire be made, say, one-half the capacity of each of the other fuses, this condition will be relieved by the blowing of this fuse, and as the lamps in the live circuit would not be anywhere near candle-power if the circuit remained intact, the blowing of the middle fuse will not be any disadvantage to the user of the lamps. Some makers avoid the contingency just described by dividing each secondary coil into two sections and connecting a section on one leg in series with a section on the other leg of the core, so that current applied to either pair of the secondary terminals will circulate about both legs of the core.

In the case of two-phase distributions each circuit may be treated as entirely independent of the other so far as the transformers are concerned. Two transformers are used, one transformer being connected to one primary phase and supplying one secondary phase, and the other transformer being connected to the other primary phase and supplying the other secondary phase, as indicated in Fig. 6, exactly as though each primary and secondary phase were an ordinary single-phase system independent of the other phase. In such cases it is possible for the two phases to remain electrically independent throughout the system, although it is not customary to thus arrange the wiring.

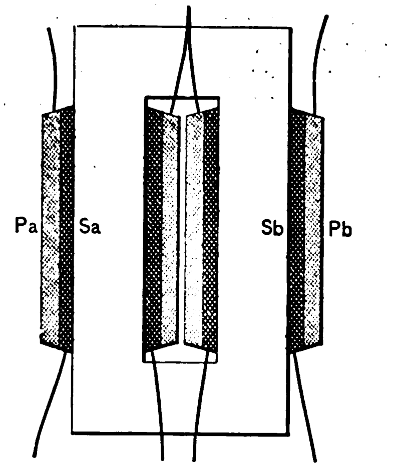


FIG. 4.—ORDINARY CORE-TYPE WINDING.

A method of connection commonly used to obtain economy in wiring is that shown by Fig. 7, where the primaries of the transformers are connected independently to the two phases and the secondaries are joined to a three-wire distribution, the middle wire being about one-half larger than each of the two outer wires. In the former case, Fig. 6, it makes no difference which secondary terminal of a transformer is connected to a given secondary wire, so long as no transformers are used in multiple. For example, referring to the diagram, the left-hand secondary terminal of transformer *A* could just as well be connected to the lower wire of the secondary phase, *A*, and its right-hand terminal connected to the upper wire, the only requirement being that the two pairs of mains shall not be "mixed," that is to say, transformer *A* must not be connected with one secondary terminal to phase *A* and the other to phase *B*. In the case shown by Fig. 7 there is not quite so much freedom in making connections. One secondary terminal of each transformer must be connected to one of the outer wires and the other two terminals must be both connected to the larger middle wire of the secondary system. It makes no difference, however, which two secondary terminals are joined, so long as the other terminal of each transformer is connected to an outer wire of the secondary system.

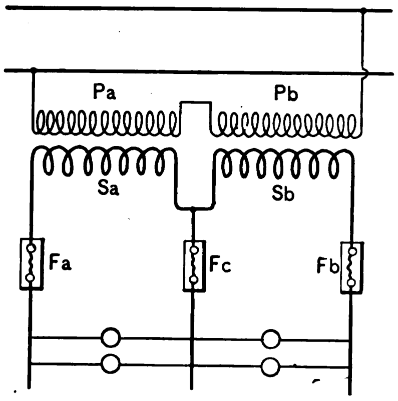


FIG. 5.—THREE-WIRE SECONDARY SERVICE.

The methods of making three-phase connections are more rigid, as the three phases are inseparably interlinked. There are two ways of connecting up the primaries and secondaries, one known as the "delta" connection and illustrated diagrammatically by Fig. 8, and the other known as the "star" connection and illustrated by Fig. 9. In both diagrams the line wires are lettered *A*, *B* and *C*. Fig. 10 shows the primaries and secondaries connected up delta fashion, corresponding to Fig. 8, and Fig. 11 shows them connected up star fashion, corresponding to Fig. 9. In both of the latter sketches the secondary wires are lettered to correspond with the respective primary wires. When the primaries are connected up delta fashion, the voltage between the terminals of each primary winding is the same as the voltage between the corresponding two wires of the primary circuit, and the same is true of the secondary transformer terminals and circuit wires.

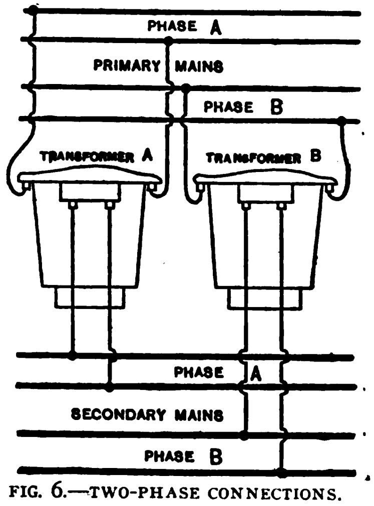


FIG. 6.—TWO-PHASE CONNECTIONS.

The current, however, flowing through the transformer winding is less than the current in the line wire, for the reason that the current from any one line wire divides between the windings of two transformers. For example, in Figs. 8 and 10, part of the current from the line wire *A* will flow from *A* to *B* through the left-hand transformer, and part from *A* to *C* through the right-hand transformer; if the current in the line wire, *A*, is 100 amperes, the current in each transformer winding will be 57.735 amperes. When transformers are connected up star fashion, as in Figs. 9 and 11, the current in each transformer winding is the same as that in the line wire to which it is connected, but the e.m.f. between the terminals of each transformer winding is 57.735 per cent of the e.m.f. from wire to wire on the circuit. For example, if the primary e.m.f. from *A* to *B* is 1000 volts, the e.m.f. at the terminals of the left-hand transformer (from *A* to *J*).

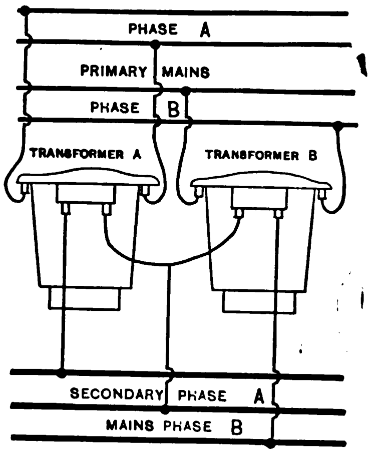


FIG. 7.—TWO-PHASE CONNECTIONS; THREE-WIRE SECONDARY.

will be only 577.35 volts, and the same is true of each of the other transformers if the system is balanced.

These statements apply, of course, to both primary and secondary windings, from which it will become evident that if the three transformers of a three-phase circuit be connected up star fashion at the primaries and delta fashion at the secondaries, the secondary voltage will be lower than if both sides are connected up star fashion. For example, if the transformers are wound for a ratio of 10 to 1 and are connected up with both primaries and secondaries alike, no matter whether it be delta fashion or star fashion, the secondary e.m.f. will be one-tenth of the primary e.m.f.; but if the primaries be connected up star fashion on a 1000-volt circuit and the secondaries be connected up delta fashion, the secondary voltage will be only 57.735 volts instead of 100 volts. The explanation of the difference between the voltage per coil in a delta system and that in a star system is that in the former each winding is connected directly across from wire to wire; whereas in the star system two windings are in series between each pair of line wires. The voltage of each winding is not reduced to one-half, however, because the e.m.fs. are out of phase with each other, being 120, or one-third of a cycle, apart; consequently, instead of having 500 volts at the terminals of each coil in Fig. 9, the voltage is 577.35. The same explanation applies to the current values in a delta system. The current phase between *A* and *B*, in Fig. 8, is 120 removed from that in the winding between *A* and *C*; consequently, the sum of the two currents in the wire, *A*, is 1.732 times the current in each wire; or, to state it the opposite way, the current in each winding is .57735 of the current in the wire, *A*. It will be well for the reader to remember that in all cases e.m.fs. differing in phase when connected in series, combine according to the well-known law of the parallelogram of forces; current differing in phase and connected in parallel combine according to the same law.

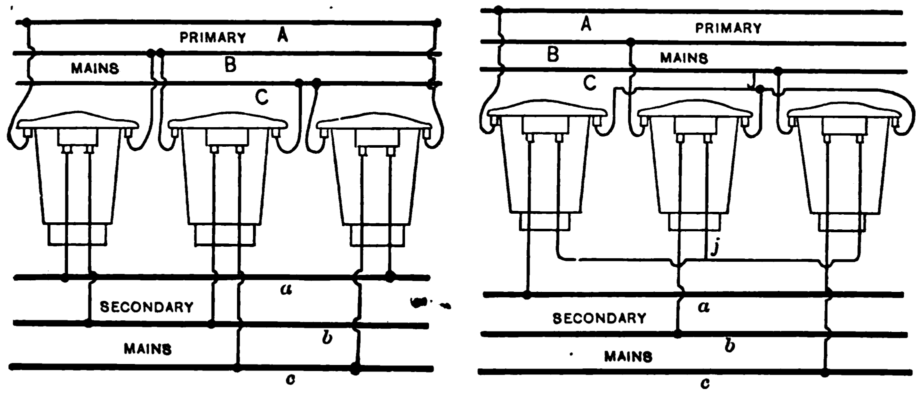
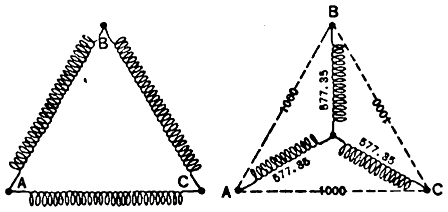


FIG. 10.—THREE-PHASE DELTA AND STAR CONNECTIONS.—FIG. 11.



FIGS. 8 AND 9.—DELTA AND STAR DIAGRAMS.

Letters on Practical Subjects

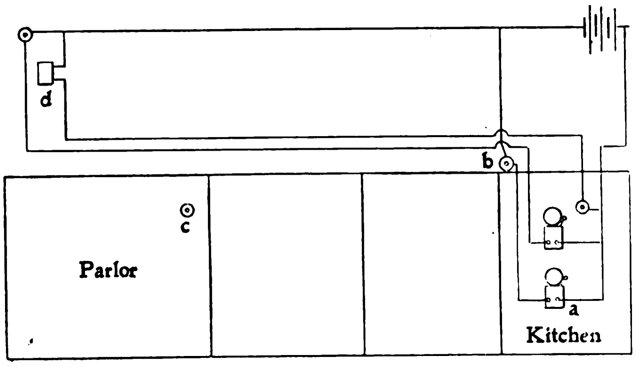
Problem in Bell Connections.

To the Editor, American Electrician:

I submit herewith a problem in bell connections, the object being to use the least amount of wire that will produce the desired results. The diagram shows the wiring for an ordinary flat equipment of door bell and door-opener, with an additional bell, *a*, and push-button, *b*. It is desired to put a button, *c*, in the parlor and connect it to ring one of the bells and operate the door-opener, *d*, simultaneously. The kitchen is the only place where the existing wiring is accessible for making connections The battery is in the basement. Ground connections not allowed.

C. H. POOL.

New York.



PROBLEM IN BELL CONNECTIONS.

◆◆◆

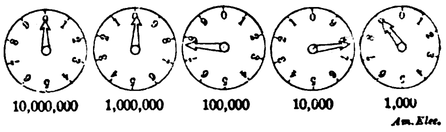
Tricky Meter Reading.

To the Editor, American Electrician:

Having seen in several numbers of the AMERICAN ELECTRICIAN tricky meter readings, I beg to submit the accompanying reading for consideration by your readers.

FRANK ZIMMERMAN.

Allentown, Pa.



TRICKY METER READING.

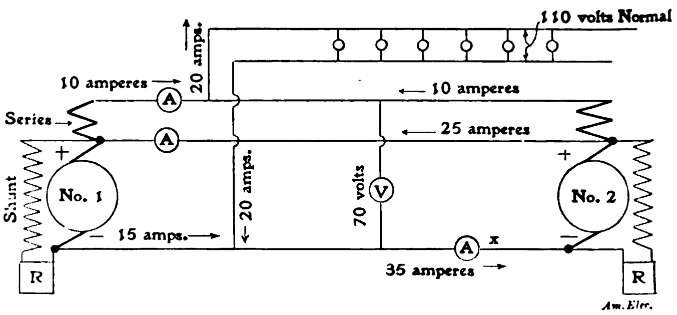
Solutions of the foregoing problems intended for publication in the November number must reach this office not later than October 18. No solutions will be published in the December number. Readers desiring to submit solutions for criticism but not for publication are cordially invited to do so.—EDITOR.

◆◆◆

Peculiar Trouble with Generators Operating in Parallel.

To the Editor, American Electrician:

I was recently confronted with a peculiar trouble when operating two generators in parallel. The machines are of the same size and make and are slightly under-compounded. In ordinary operation each machine carries its load of 50 amperes, and the machines divide the load almost equally. The shunt field resistance ordinarily is all cut out. Weakening the shunt field of No. 1 by cutting in some resistance causes it to motor and the voltage drops to 60 or 70 volts, causing the condition shown in the accompanying sketch. By cutting in more resistance the equalizer current increases and the voltage drops still more. When the experiment was tried there were enough lamps in circuit to give a normal load of 25 amperes on each machine, or one-half load on each generator. The current shown by an ammeter placed at *x* did not at any time exceed 50 amperes. Why should the voltage drop with such a slight flow of current? Another peculiar case happened with a motor running under no load and connected to a single generator circuit. The generator



GENERATORS OPERATING IN PARALLEL.

was stopped without the generator or motor switches being opened and the counter e.m.f. of the motor reversed the flow of current and changed the polarity of the generator. In this instance the generator was over-compounded and the shunt field rheostat was probably turned off before the generator was stopped.

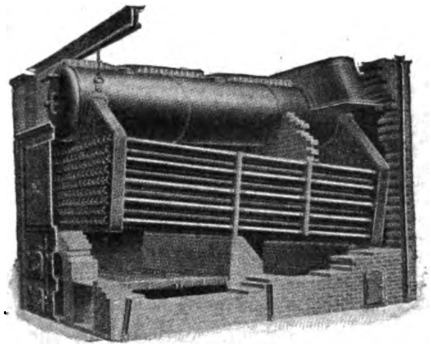
Madison, Wis. H. V. **Forest.**

◆

Sprung Tubes in Water-Tube Boilers.

To the Editor, American Electrician:

The writer has had brought to his attention a peculiar state of affairs in connection with a battery of water-tube boilers of a standard make which is considerably puzzling, and for various reasons submits the case to your readers for a solution. The boilers, which are of 125 horse-power each, are fitted with grates about 5 ft. by 5½ ft. and a mixture of 1/3 buckwheat with ⅔ bituminous coal is used for fuel. Feed water is pumped in against 198 lbs. boiler pressure and at a temperature of about 205°, the water being a mixture of condensation from the surface condensers and river water, about .005% of oil being present in the condenser water. The bottom tubes are of No. 9 gauge and the boiler was inspected by a standard insurance company for high pressure when the plant was installed, which was only recently. Upon removing the hand-hole plates for inspection, the bottom row of tubes from the header to the bridge wall immediately over the grates was found curved up about one inch. The tubes do not show traces of oil and seem to be perfectly clean. Could a high fire, due to the coking of the fuel, cause the condition mentioned, or could it be that the boiler had been at some time forced and the circulation was not rapid enough? Why should the tubes curve up and not sag? I should be pleased to get the opinion of your readers on the matter.



WATER-TUBE BOILER.

Poughkeepsie, N. Y. J. C. **Fuller.**

◆

Simple Three Party-Line Telephone System.

To the Editor, American Electrician:

There are many party-line schemes based on the strength and polarity of current, which require special apparatus not always convenient to obtain. I have devised the following arrangements for a three-party line system which can be applied to any short private or exchange telephone line by adding two strap keys to each instrument. Fig. 1 shows the principle of the arrangement. Telephones *A*, *B* and *C* are connected in series by wires 1, 2 and 3. If *A* should desire to ring *B*, it is obvious that if the wires 1 and 3 are short-circuited while *A* is ringing, only the telephone bells of *A* and *B* would respond. Similarly, *A* could ring *C* only by closing wires 2 and 3, or *C* could ring *A* and *B* and *B* could ring *A* and *C* by short-circuiting the proper wires. If now wires 1 and 2 are made the two wires of a metallic circuit and wire 3 be replaced by a ground, a three-station selective party line results. Fig. 2 explains this more clearly. This scheme, while very simple, has the defect that if the button is not kept pressed while the generator handle is being turned all three stations will be rung up. By wiring the telephone as shown in Fig. 3, this defect will be obviated, it being necessary to break the circuit of the lines you do not want in order to ring the proper station. Fig. 4 shows the system applied to bridging phones. The system can be further extended to four phones by using three wires as shown in Figs. 5 and 6, but beyond this the signalling apparatus becomes too complicated. For short lines no trouble is experienced in talking through the one or two 80-ohm ringers. If bridging phones are used on long lines, it might become necessary to place a set of ringer coils on the dead-ends of the lines at the terminal stations in order to balance the line, the center station, of course, being across the line.

New York. J. W. **Strippel.**

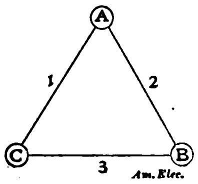


FIG. 1.

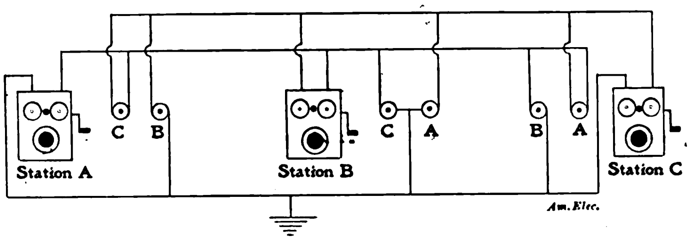


FIG. 2.—THREE-STATION SELECTIVE PARTY LINE.

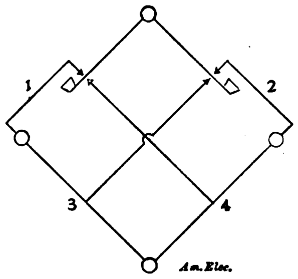


FIG. 5.

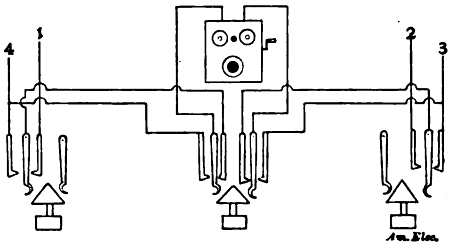


FIG. 6.

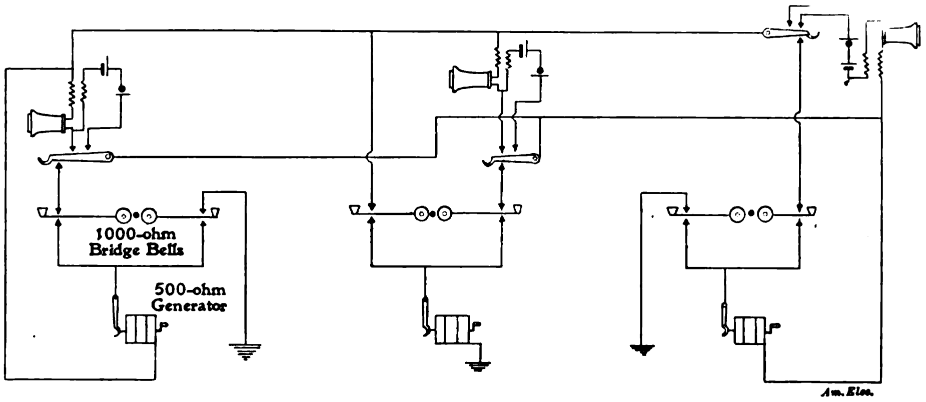


FIG. 4.—SYSTEM APPLIED TO BRIDGING TELEPHONES.

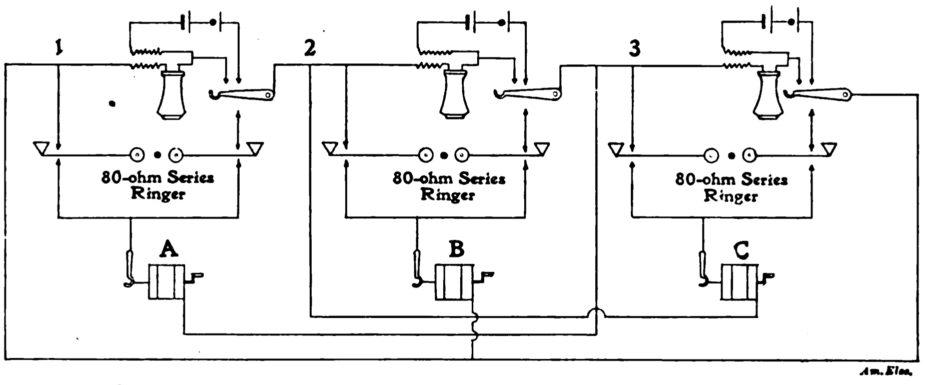


FIG. 3.—DIAGRAM OF CONNECTIONS FOR THREE- STATION SELECTIVE PARTY LINE.

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

Is there any specific acknowledged limit beyond which it is not commercially profitable to distribute direct current? J. K. I.

There is no hard-and-fast limit; but it is usually considered preferable to use alternating current when the radius of distribution exceeds 2½ miles.

Where should equalizer-switch pedestals be located? A. E. E.

At points as near the respective machines as practicable, keeping in mind that the equalizing conductor should be laid in as nearly a dead straight line, from end to end, as possible.

Where can I obtain instruction in the design and winding of motors which will enable an electrical machinist or other skilled worker to build a machine properly without understanding the science of dynamo design? F. C. S.

A series of articles of this character begins in this number; see page 538.

How many cells of battery are required to maintain four 20-volt lamps taking ¼ ampere each? (2) How should the outfit be connected up? O. DeC.

About twenty cells of primary battery or ten cells of storage battery. (2) Connect the battery cells in series and the lamps in parallel.

Please give data for the construction of an induction coil to give a 2½ or 3-inch spark. J. H. B.

Core of No. 22 iron wires 10 inches long, bundled to 1⅛ inches diameter. Primary winding, 2 layers of No. 13 wire, covering 9 inches of the core. Secondary winding, 4 lbs. No. 36 double silk-covered wire, wound to cover 8½ inches of the primary coil length. Condenser, 60 tinfoil sheets, each 6 ins. x 8 ins.; dielectric, heavy bond paper, 7 ins. x 10 ins.

Under ordinary central station conditions is a simple condensing engine ever preferable to a compound condensing engine? (2) Is there any preference between a vertical and a horizontal engine for central station service? K. F. U.

Not in stations of appreciable magnitude. (2) Each has several advantages over the other; local conditions almost always determine the choice. The vertical type shows much less cylinder wear and less tendency to rack foundations; the horizontal type is much more accessible and easier to dismantle, and so on.

A 50-light T.-H. arc light dynamo supplying seventeen lamps runs extremely hot; a resistance in parallel with the field windings relieves the heating, but it is not convenient to use it regularly. What causes the heating and how can it be remedied? H. S. B.

The heating is due to the fact that at light loads the position of the brushes is such that the armature coils are short-circuited during a considerable proportion of each revolution. It can be cured only by keeping a resistance in shunt to the field winding, so that the regulator will adjust the brushes to a better position.

How far apart should the wires of a 440-volt, three-phase circuit be spaced for best results? (2) What changes in the windings of the three-phase synchronizer described in the May number would be necessary to make it applicable to 440-volt machines? C. W. C.

Put all three in a single conduit, if indoors; if it is an outdoor line, put the wires 6 inches apart. (2) The primary coils of the three-phase transformer should be wound with 2238 turns each of No. 27 double silk covered wire; the primary coil of the single-phase transformer should contain 1580 turns of No. 29 double silk covered wire. The secondary coils require no changes.

What would be the dimensions, etc., of a condenser of one microfarad capacity? (2) What is the "S. K. C. system" and what do the letters mean? A. R. E.

The data depend on the kind of dielectric used. If you use ordinary glass sheets 1/16 inch thick, 18,000 square inches of tinfoil (counting one side only of each sheet) will be necessary. If the tinfoil sheets were 20x12½ inches, you would require 72 sheets. The glass panes must be considerably larger than the tinfoil sheets, say, 14x24 inches. (2) It is the system of apparatus developed by Messrs. Wm. Stanley, John Kelly and C. C. Chesney and built by the Stanley Electric Mfg. Company.

Several of our armatures have cross-connections between different points of the windings, said to be equalizers. The machines work as well without them as with them if the brushes are in good condition. What are they for? (2) Can a magnet be made to work on alternating current as well as on direct? H. W. W.

The connections are to make sure that points of the armature which should be at equal potential shall be so regardless of lack of symmetry in the field magnetization or the brush contact resistance. Without them, such lack of symmetry, if it should occur, will cause differences of potential between these points which will send heavy local currents through the armature winding. (2) Yes; but a magnet for alternating current is of greatly different design and construction from one built for direct current.

Will a four-pole, direct-current dynamo work as well with four shunt field-magnet coils and two series field-magnet coils as if the series winding were divided among all four poles equally? (2) What is the lowest resistance that can be connected across the terminals of a constant-potential dynamo without injuring the machine? W. C. A.

If the machine has a two-path armature winding it will probably work as well, but if not, it will be better to use four series coils. (2) A resistance of the number of ohms equal to the voltage of the machine divided by its rated current-carrying capacity. Thus, a 110-volt 50-ampere dynamo may have a resistance of 110 ÷ 50 = 2.2 ohms connected to its brushes without damage; any lower resistance would produce overheating if kept connected up for a considerable length of time, such as two or three hours.

What is the resistance of the ground between two copper plates each 12 inches square buried one mile apart? (2) Does the resistance vary inversely as the area of the plates and directly as the distance between them? (3) Do the turns of wire farthest away from the core in a magnet coil have the same effect on the core as the turns nearest the core? (4) Does it make any difference whether the primary winding of an induction coil is inside or outside of the secondary winding? C. M. F.

It varies enormously; there is no formula that will give even the roughest approximation. (2) The size of the plate affects the resistance of contact between it and the surrounding earth, but does not affect the resistance of the path through the earth, of course. The resistance of contact, however, is vastly higher than that of the earth itself. Consequently the distance between the plates has less effect on the total resistance of the circuit than the size of the plate and character of the contact with the earth. (3) Practically, yes. (4) So far as the mutual induction between the two windings is concerned, no. There are disadvantages in practice, however, which make such an arrangement undesirable.

Why will not a shunt-wound dynamo build up in the direction opposite to normal when the connections between the brushes and field winding are reversed? (2) What is the origin of the formula

$$\frac{16{,}039\ H.P.\ D}{E\ eff.\ V} = d^2$$

giving the size of wire for motor wiring. *H.P.* is the horse-power of the motor, *eff.* is its efficiency, *D* is the distance, *E* is the e.m.f. at the motor and *V* is the drop in volts in the line? J. B. D.

Because the e.m.f. generated by the residual magnetism tends to magnetize the field in opposition to the magnetism generating it; in other words, the machine kills its own residual magnetism. (2) It is derived from the formula:

$$\frac{21.5\ I\ D}{d^2} = V,$$

in which I is the current. The resistance of copper wire is taken at 10¾ ohms per foot for one circular mil cross-section; there are two wires, so that the length of wire is twice the distance, D, and the resistance per foot of line is 21.5 ohms for unit cross-section. Dividing 21.5 by the cross-section of the wire ($21.5 \div d^2$) gives the resistance per foot of line; multiplying this by the distance gives total resistance, and multiplying this by the current gives the drop, according to Ohm's law. Now, the current taken by a motor is equal to the watts divided by the voltage, E, and the watts are equal to the horse-power multiplied by 746 and divided by the efficiency of the motor expressed decimally; therefore, $I = 746 \times h.p. \div E \times efficiency$, which changes the fundamental formula to

$$\frac{21.5 \times 746 \times h.p. \times D}{E \times efficiency \times d^2} = V.$$

Multiplying 21.5 by 746 and transposing d^2 and V will give the formula you quote.

HAMILTON-HOLZWARTH STEAM TURBINE.

The application of the steam turbine as a prime mover for driving electric generators has in the last few years been brought into prominence in steam plant construction, insomuch so that it bids fair to become a formidable competitor of the reciprocating engine. Some of the reciprocating engine builders have therefore taken up the manufacture of turbines, and one of the latest to make its appearance is the Hamilton-Holzwarth steam turbine built by The Hooven-Owens-Rentschler Company, of Hamilton, Ohio. These turbines, like those of the Parsons type, have a plurality of stationary discs and running wheels, the discs and wheels having vanes all around their circumference. It differs from the Parson, however, in that expansion takes place only in the stationary blades and not in both the blades and running wheels. The radial length of the vanes of the stationary blades is increased to correspond to the volume to which the steam has expanded. The number of wheels and vanes in the turbine is also considerably less than those of the Parsons type. The balance pistons are omitted because the axial thrust of the running wheel shaft is said to be so small that it can easily be taken up by a thrust ball-bearing.

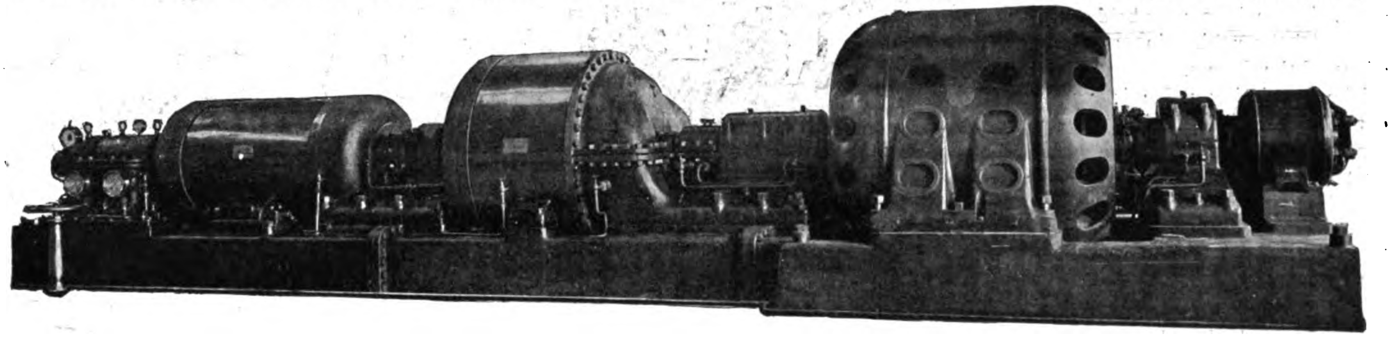


FIG. 1.—HAMILTON-HOLZWARTH STEAM TURBINE.

For units of 750 kilowatts and upward the rotating body is divided into two parts, a high and a low-pressure turbine; smaller units are built in one turbine casing. The turbine casing and pedestals for the bearings in the generator are placed upon a bed plate of the box pattern, and all steam, oil and water piping, including the steam inlet, regulating and by-pass valves, are within and below the bed plate. After passing through the steam separator, the steam passes through the main inlet valve which has an extended stem connected with its floor stand and a hand-wheel located on the floor close to the high-pressure end of the turbine. It then passes through the regulating valve and from there through a curved pipe to the head of the high-pressure turbine. From the ring channel of this head the steam flows through the first set of stationary vanes, which changes its direction and imparts the necessary velocity. From here the steam flows in a full cylindrical belt interrupted only by the vanes of the first running wheel, and from here to the following stationary discs, and so on. From the last running wheel the steam is led through receiver pipes to the front head of the low-pressure casing, or if there is only one casing, immediately to the condenser. The condenser, which may be either of the jet or surface type, is placed as near as possible to the exhaust opening.

In the low-pressure casing the steam is distributed in the same manner as in the high-pressure turbine. The low-pressure front head, however, has an additional nozzle through which live steam enters for use in case of overload. The design is such that this steam, which is controlled by the governor, exerts no back pressure to the steam from the high-pressure turbine. On the contrary, it is said to work like an injector, sucking the low-pressure steam through the stationary vanes of the low-pressure turbine. The first stationary disc of the low-pressure turbine has guide vanes all around its circumference so that the steam enters in a full cylindrical belt interrupted only by the guide vanes. These vanes have a varying radial height increasing in the direction in which the steam flows. This allows the steam to expand within the stationary vanes. At the same time, the vanes are said to guide the steam under such a small angle that the force with which the steam impinges on the next following running wheel is as effective as possible.

The hub of the running wheel runs in the bore of the stationary discs, and the manufacturers claim that inasmuch as the stationary discs are extended nearly to the shaft of the turbine the clearance, and hence the leakage losses, have been restricted to a minimum practical limit. The stationary discs are located in grooves in the turbine casings, which are horizontally split, and so designed that with the smallest weight the strains in the material, due to the static steam pressure, do not exceed the limits usually allowed in ordinary practice. The vanes are of drop-forged steel, milled and located in a groove on the outside periphery of the discs. They are fastened to the discs by rivets, after which the discs and vanes are ground on their outside edges. A tough steel ring is then shrunk on the outside periphery of the vanes and steam channels.

The running wheels are built with cast steel hubs, and steel discs are riveted to both sides of this hub and form a circumferential ring space in which the vanes are held by means of rivets. The vanes are milled on both edges on the influx and efflux sides of the wheel, and in order to reduce their weight as much as possible, as well as their stress on the rivets, they are made hollow lune shape. Steel clips with welded channels are pressed on one end, after which they are milled so that they fit on the running wheels, which are then carefully balanced.

The bearings are the only part of the turbine proper, with the exception of the governor regulating mechanism and pump, where metal comes in contact with metal, and here the running parts are amply supplied with oil. The pedestals and caps are designed in such a mamner that the oil inlet and outlet are placed close together on the side of the pedestal so that no piping has to be deranged to take out the bushings. The oil flows to the bottom bushing under a slight pressure and then with the rotating shaft, being finally taken off in the cap. From here it flows back to the oil outlet in the pedestal. With the thrust ball bearing on the thrust side of the turbine, the manufacturers claim that it is possible to move the whole shaft in an axial direction and to change the position of the running wheel to that required by the stationary discs. Flexible couplings are used between the high-pressure and the low-pressure shafts and between the low-pressure shaft and generator shaft, so that each shaft can be fixed and located without affecting the location of the others.

Each half of the flexible coupling consists of a disc screwed upon the shaft and secured to it by means of a key. Near the outer circumference these discs have steel laminations connected to brushes and firmly secured to the coupling disc. The brushes of one disc fit between the corresponding brushes of the other disc, so that the several pairs of brushes distributed over the circumference will always lean together in whatever direction the coupling may be turned. The spring of the laminations is said to insure the flexibility needed.

At the four places where the shaft enters the steam chambers of the casing a stuffing box of special design with interchangeable parts is used. These boxes contain no half rings and the design is based on the fact that a shaft revolving in a sufficiently long box with small clearance throttles the steam which tries to escape along the shaft. In order to avoid a long box, the builders make a practical use of the idea embodied in the telescope. A ring fastened to the shaft and revolving with it extends axially into a deep groove of another ring which does not revolve. By means of this annular space, half rings pressing against collars on the shaft are avoided. The stationary curved ring presses against the adjoining bearing bushings, and the space between this ring is connected with a drain pipe on the pressure side and a waterpipe on the vacuum side. By this means the manufacturers claim that it is impossible for steam to leak along the shaft.

The governor is of the spring and weight type and is directly driven by the turbine shaft. Two discs, key-seated to the shaft, drive by means of rollers two weights sliding along a cross-bar placed at right angles through the shaft and pressing two springs against two nuts on the same cross-bar. Every outside movement of the weights caused by the increase or decrease of speed is transmitted by means of levers to a sleeve actuating the regulating mechanism. The governor is closed on both sides by the discs and by a ring secured by concentric recesses to the disc. Thrust ball-bearings and frictionless roller-bearings are used to decrease the friction between the governor and the regulating mechanism, and the shaft is coupled to the sleeve with a special coupling to avoid the friction due to the shifting of the governor sleeve along the key which transmits the turning movement of the shaft. On both ends of the sleeve two fingers extend into the corresponding spaces on the shaft. These fingers are held apart by means of steel balls rolling in grooves cut in the edges of the fingers.

The regulating valve is connected by a curved pipe with the high-pressure front head on one side and with the inlet valve on the other. The valve is of the double-seated poppet type, the valve seats being of tough cast steel and the valve body of cast iron. Immediately below the regulating valve, and forming a part of it in one steam chamber, is located the by-pass regulating valve. This valve controls the quantity of steam flowing directly to the by-pass nozzles in the low-pressure front head and is also of the double-seated poppet type. The main regulating valve is not actuated directly by the governor, but by means of the regulating mechanism. The principal idea of the regulating mechanism is as follows:

The stem of the regulating valve is driven by means of bevel gears by a shaft which is supported in frictionless roller bearings. On this shaft there is a friction wheel which the governor can slide across the face of a friction disc (which is continually revolving) by means of its sleeve and bell crank lever. The continually revolving friction disc is keyed to a solid shaft which is driven by a coupling from a hollow shaft. This hollow shaft is driven by means of worm gear by the turbine shaft. The solid shaft with the always revolving friction disc can be slightly shifted by the governor sleeve, so that the two friction discs come into contact when the sleeve moves; that is, when the angular velocity changes. If this change is relatively great, the sleeve will draw the periodically revolving friction disc far from the center of the always revolving one, and this disc will drive quickly the stem of the regulating valve and regulate the steam flow.

As soon as the angular velocity falls below a certain percentage of the normal speed the driving friction disc is drawn back by the governor, the regulating valve remains open and the whole regulating mechanism rests or stops, though the shaft is still running. This is an important feature of the regulating mechanism on account of the fact that the turbine continues to run for ten to twenty minutes after the main inlet valve has been closed.

The governor shuts down the whole turbine as soon as the angular velocity reaches a point 2½ per cent. higher than normal. Even if any accident should happen to the governor, due to imperfect material, breaking or weakening of the springs, etc., the only thing which, the builders say, would result from this accident would be a shutdown of the turbine, hence the omission of an auxiliary governor for safety, as required when other types of governors are furnished.

In order to change the speed of the turbine while running, which might be necessary in order to run the turbine parallel with another prime mover, a spring balance attached to the bell crank lever of the regulating mechanism is provided. The hand wheel of this spring balance is outside of the pedestal for regulating the mechanism, near the tachometer and floor stand and hand wheel. With this spring balance the normal speed of the turbine may be changed 5 per cent. either way.

All bearings of the entire turbo-generator are fed with a sufficient quantity of oil to insure cool running. The oil flows from an oil tank of large capacity (a part of the bed plate being used for this purpose) to the oil pump, which is driven by means of worm gearing by the turbine itself. From here the oil is forced through the bearings and flows back to the oil tank. Here it is cleaned by flowing through a strainer and has sufficient time to radiate part of the heat to the walls of the bed plate. The pressure pipe to each bearing can be closed by a valve so that one can easily regulate and control the flow of oil to the different bearings. As all revolving parts of the turbine are enclosed and the principal part of the regulating mechanism operates in a bath of oil, the whole turbine is lubricated automatically.

◆◆◆

A NEW FORM OF OIL SWITCH.

The use of the oil switch is becoming more prevalent each year, especially on high-voltage work wherein its principal field lies. Prominent among the various types are those operating with a horizontal break. In this form the contacts are usually located near the surface of the oil and the arc when drawn is carried upward by the generated gases, increasing in length and breaking just below the surface of the oil. Fig. 1 herewith shows the form M oil switch brought out by the Stanley Electric Manufacturing Company, Pittsfield, Mass. The switch is of the horizontal-break form and is furnished complete with oil and tank. The breaking distance in the lower voltages corresponds to standard practice, but in the higher voltages is increased by multiplying the number of breaks. Both the fixed and moving contacts are disc-shaped with round edges and are interchangeable. When the switch is opened the arcing is said to take place between portions of these rounded edges rather than over the flat portions which form the contact surfaces. From the back of each disc a threaded projection extends which in the case of the fixed contacts screws directly into the end of a hollow stud. In the moving contacts, however, two nuts secure each to a connection strip. This construction facilitates removal and the expense of replacing the discs is trifling. Portions of the rounded edges after long use become damaged by the arc and new portions can be easily brought into play by giving the discs a partial turn. This prolongs the life of the switch materially. The fixed contact discs are held against the lower ends of the insulators by hollow studs into which they screw, and the lead wires are soldered into the top of these studs. By means of ball joints the moving contact discs are mounted upon the carriers which are rigidly attached to the driving rod. The discs are said to be self-aligning in regard to the fixed discs against which, when the switch is closed, they are pressed by strong coil springs. All parts requiring renewal can be removed and replaced with an ordinary wrench and screw-driver. The switches may be used in connection with over-load time limit or reverse current relays. They are built for 2500 and 6600 volts in 2, 3 and 4-pole single or double-throw, with or without enclosed fuses and holders or over-load attachment.

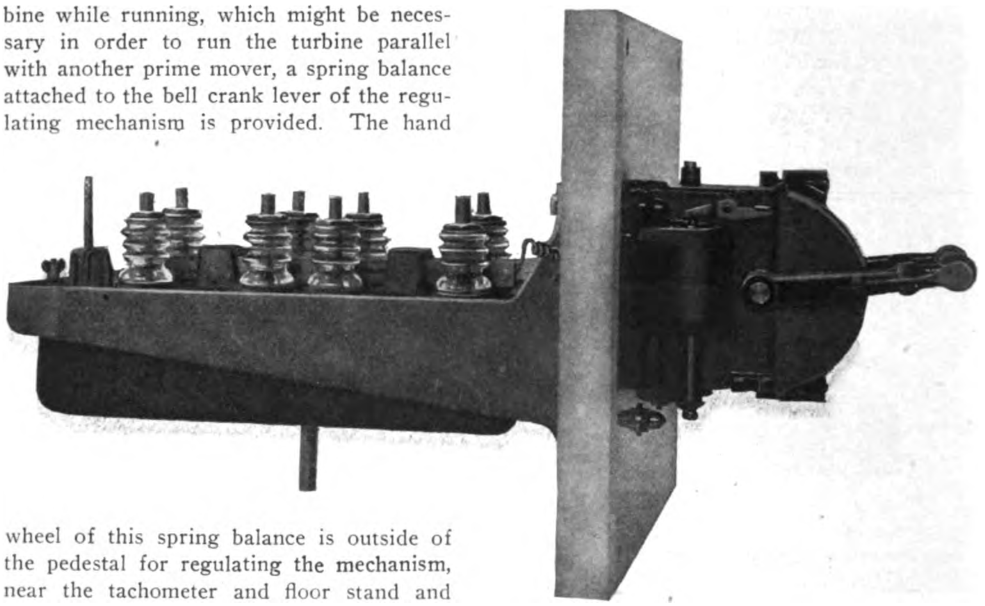


FIG. 1.—STANLEY FORM M OIL SWITCH.

New Apparatus and Appliances

A PUSH-BUTTON PENDANT SWITCH.

The Trumbull Electric Manufacturing Company, of Plainville, Conn., has just brought out a new pendant switch shown by Fig. 1 herewith. The switch is neat in appearance and is finished in nickel or polished brass. It is guaranteed to operate successfully at its rated capacity (10 amperes and 125 volts) 10,000 times without injury. The switch is a snap switch of special design. The mechanism is somewhat similar to that of the push switch, excepting that it is arranged to operate by means of only one button. The switch proper is of brass, each end of the switch blade being carried by the rotation of the switch between a pair of spring-copper clips. The mechanism is completely housed in porcelain and ample space is provided for making connections.

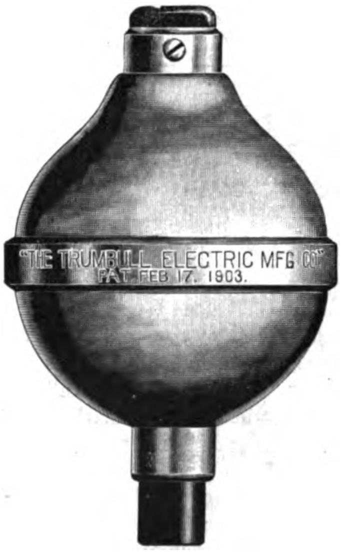


FIG. 1.—PUSH BUTTON PENDANT SWITCH.

VOLTMETER AND GROUND DETECTOR SWITCH.

Figs. 2 and 3 show front and rear views of style H voltmeter and ground detector switch made by the J. Lang Electric Company, of Chicago, Ill. The switch is built only for rear board mounting, and in sizes from 3 to 12 ins. inclusive. It is said to be compact, durable and without troublesome, coiled springs, and the contact surfaces are claimed to be ample and self-cleaning. A feature of the switch are the fuse terminals in each leg of the circuit, which are a self-contained part of the switch. It is not, therefore, necessary to place a cluster of fuse blocks on the board in addition to the voltmeter switch. Link or enclosed fuses may be used.

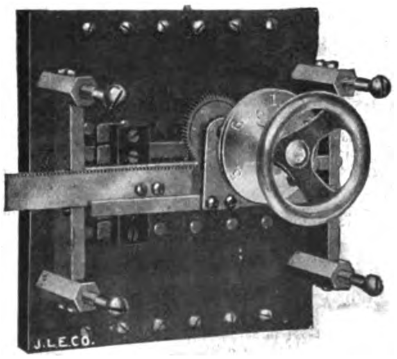


FIG. 2.—FRONT OF VOLTMETER SWITCH.

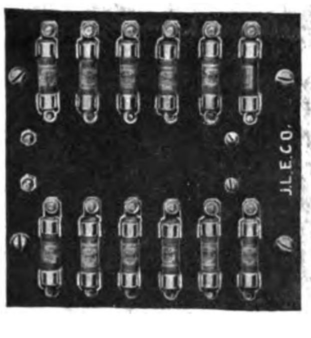


FIG. 3.—REAR OF VOLTMETER SWITCH.

"STANDARD" STATION PHOTOMETER.

Fig. 4 herewith shows the "Standard" station photometer made by the Dwyer Machine Company, of Lynn, Mass. This instrument, it is claimed, possesses many practical features as a result of every day experience, and all the parts are made of either iron or brass. The shadow car runs on a machine-planed track and is operated by a hand wheel. The lamp-revolving mechanism is started and stopped by a foot-operated clutch. Referring to the illustration, the right hand end is intended for the lamp used as a standard, and the left hand end for the lamps being measured. To set the instrument for work, a petty standard is made by placing a lamp taken from those being measured or a lamp kept for the purpose, in the right hand socket, and a calibrated standard in the left hand socket, care being taken to point the arrow which is usually affixed to such lamps along the axis of the instrument. The primary rheostat, which is of the sliding type, is set to its maximum resistance, the current is switched on and then adjusted until the voltmeter indicates the potential of the calibrated standard. When the voltmeter indicates this potential, it is clear that the lamp is giving standard candle power. The petty standard is now set to this one by balancing the shadow car between them, or if this point proves to be far removed from the center of the instrument, by adjusting the secondary rheostat until the car can be balanced sufficiently near the center to be convenient for the operator to work. The calibrated standard can then be removed and the instrument is ready for work. It will be noted that the calibrated standard is used only to set the petty standard by. This saves this lamp and with ordinary care it will last for years. A lamp to be measured is now placed in the socket from which the calibrated lamp was removed, the foot treadle is pressed, causing the lamp to revolve, the car is balanced and the candle power is read by the indication of the pointer attached to the car and also from an auxiliary scale directly in front of the operator placing the lamps in position and removing same. The reading is further facilitated by the light from a lamp which lights when a lamp is removed.

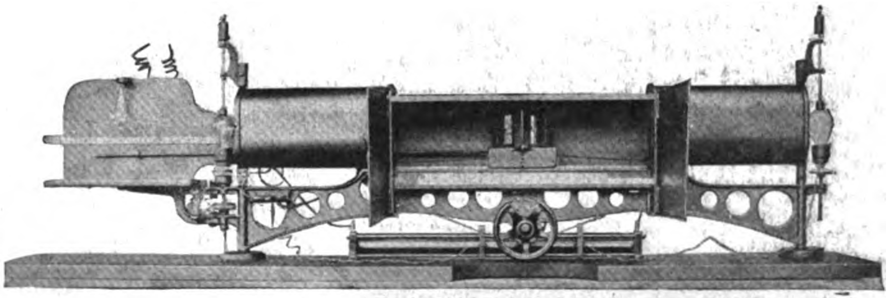


FIG. 4.—"STANDARD" STATION PHOTOMETER.

FABER BLOW-OFF VALVE.

Fig. 5 herewith shows the Faber blow-off valve, manufactured by the Liberty Manufacturing Company, of Pittsburg, Pa. In this valve a jet of steam cleans both the seat and disc after the water is shut off, but before final closing. This will be made clear by reference to the illustration. Surrounding the seat, *A*, is a chamber, *B*, into which steam is admitted at full boiler pressure through a half-inch connection leading from the steam main. The discharge takes place in the direction indicated by the arrow, and when the disc, *D*, is in the position shown, the water is practically shut off. From this point the disc moves ¾ inch before closing on the seat, and during that time steam escapes from the chamber, *B*, through the narrow slot, *E*, all around the seat. The result of this, the manufacturer claims, is the sweeping of any scale from both the seat and disc, so that when the valve closes

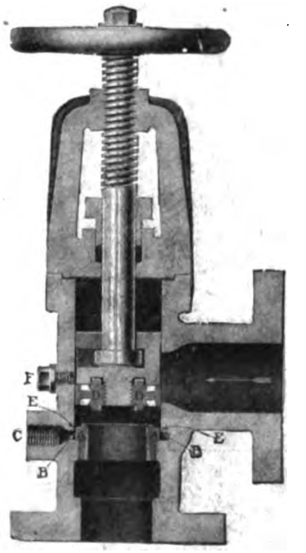


FIG. 5.—FABER BLOW-OFF VALVE.

these are clean. The connection, *C*, should be provided with a valve which should be left open all the time except when the boiler is out of service.

THE "SEMI-DIMOND" TOOL.

The emery wheel dresser shown herewith and manufactured by the International Specialty Company, of Detroit, Mich., is designed to take the place of the expensive black diamond. This is claimed to be a most efficient tool for the purpose, and the maker says will do the work of truing and shaping emery wheels in as satisfactory a manner as the diamond dresser. The "Semi-Dimond" dresser is a steel tube filled with hard abrasive, which presents new cutting edges the entire length of the tube and as long as it lasts. The dresser is not recommended for water grinders or very hard wheels, although it can be used on these if necessary. Its efficiency is best demonstrated on grades up to medium hard.

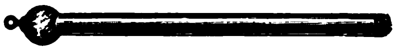


FIG. 6.—"SEMI-DIMOND" TOOL.

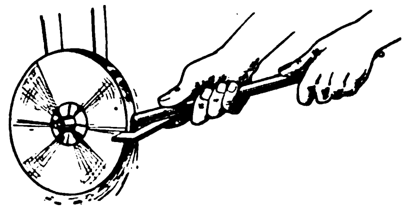


FIG. 7.—EMERY WHEEL DRESSER.

A NEW WIRE COUPLING.

A device for coupling stranded wires together, known as the Dossert type B joint, has just been placed on the market by Dossert & Company, of New York. Exceptional claims are made for it as superior in convenience, cost, conductivity and durability to the soldered joint. The joint is made of seven parts, six of which are in pairs. They consist of an inside ring, an outside ring and a compression nut. The remaining part carries nipples, on which compression nuts carrying the wire properly prepared are screwed. These nipples may be in the form of crosses or tees or may be cast on to bus-bars or fittings of any kind, and will enable the cable to be fastened securely thereto. The joint is made in the following way: The end of the cable is stripped the length of the compression nut and cleaned. The compression nut is then slipped upon the cable together with a small outside ring. The outer strands of the cable are then stripped and an inside ring is driven around the inner core of strands with a steel tube provided for the purpose. The outer strands are then molded back as nearly as may be to their original position. This can be done with a screw-driver, but a steel tube provided for the purpose is more convenient. The application of a joint of this character in the manner shown in Fig. 8 requires only seven minutes on a 1,000,000-circ. mil. cable. Figs. 9 and 10, being actual pictures of the joint itself, display its construction to better advantage. In Fig. 10 strands are cut away so as to show the inside ring. Fig. 11 displays this joint and its alternative soldered joint and underneath parts of the new joint. The makers of this joint have subjected it to tests before putting it upon the market. On millivoltmeter test the joint is claimed to show a conductivity greater than that of an equal length of wire. The mechanical strength of the joint was tested in a tension machine, where it developed more than two-thirds of the strength of the cable it united. The makers guarantee the joint to stand 50 per cent of the strength of the cable, which they claim is superior to the soldered joint on account of the amalgamating and deteriorating effect of the solder on the copper. It is also asserted that the soldered joint well made required a skilled man, while an ordinary helper has no difficulty in making the Dossert joint. The new joint wastes no cable and involves no other expense than its own cost and the time of putting it on.

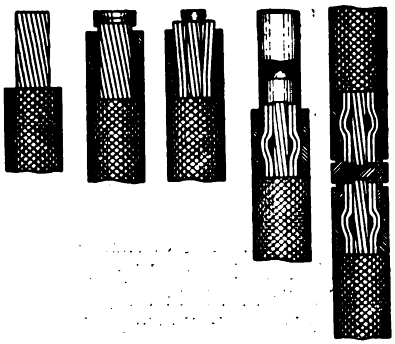


FIG. 8.—MANNER OF ASSEMBLING DOSSERT JOINT.

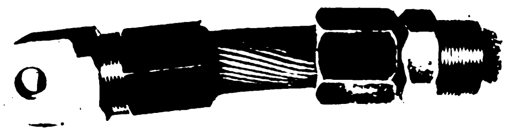


FIG. 9.—VIEW OF COMPLETE JOINT.

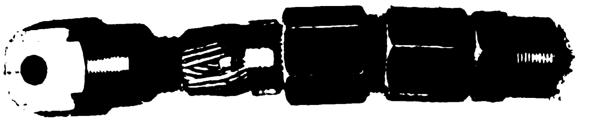


FIG. 10.—A 1,000,000-CIRC. MIL JOINT WITH STRANDS CUT AWAY.

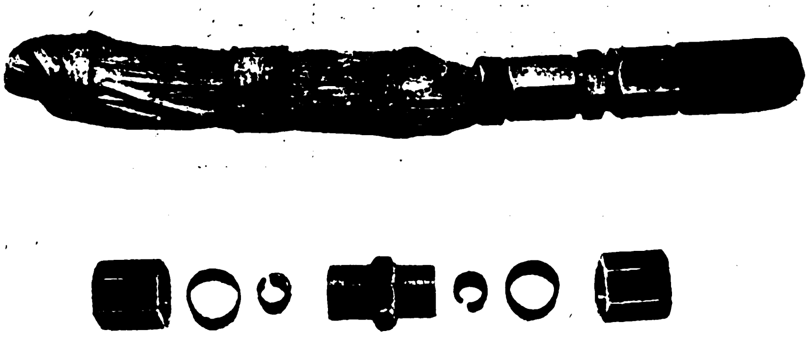


FIG. 11.—SOLDERED AND COUPLED JOINT WITH PARTS OF LATTER.

FORT WAYNE SERIES ALTERNATING SYSTEM OF STREET ARC LIGHTING.

This system, in common with other alternating series arc lighting systems, consists of a combination of a constant current regulator and a number of arc lamps connected in series, and includes the use of a "Wood" regulator which is mechanically different from any others on the market, and Form C "Wood" arc lamps specially designed for this service.

The automatic regulator consists of a W-shaped, laminated iron core and a reactance coil surrounding the center leg of the iron core. The coil and core are hung on levers supported on knife edges in such manner that the coil and core counterbalance each other and are both movable.

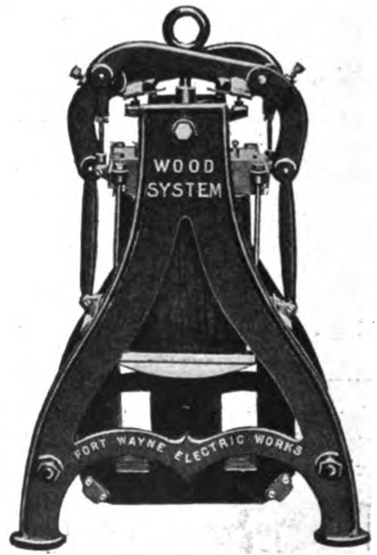


FIG. 1.—WOOD REGULATOR.

Through the lever system the coil forms a counterbalance to the heavy core and the levers are so arranged that of the total travel the coil moves over the greater portion of the distance. It is required to lift the core only through a short distance. The regulator coil is connected in series with the arc lamp circuit, to which it furnishes a constant current suitable for the arc lamps on the line. The regulation is automatic.

Any change in the resistance of the arc lamp circuit tends to produce a corresponding change in the current in the circuit, since the line voltage remains constant. But any change in the current changes the relative position of the core and coil, an increasing current bringing them closer together, a decreasing current allowing them to move farther apart.

As the core enters the coil when they approach each other, due to an increase in current, the additional reactance caused by the magnetic condition thus created serves to counteract the decreasing resistance of the line and secures such an impedance that the current remains intact.

Any decrease in the load tends to increase the current and draws the coil and core together, thus increasing impedance in the circuit, while any increase in the load tends to decrease the current and allows the core and coil to separate, thus decreasing impedance in the circuit. The result is that the current is maintained at its normal value automatically. So perfect, it is claimed, are the mechanical construction and electrical proportions of the regulator that the load may be reduced gradually from full load to no load until the regulator is directly across the line in short circuit without causing any marked change in the current. The load may also, it is said, be changed from full load to short circuit with but momentary current variation. This insures perfect protection to the system against short circuits due to failure of insulation of the outside lighting circuit.

When this regulator is intended for use on a small system of 25 lights or less the lighting system may be connected directly to the machine circuit without the use of transformers. When, however, it is necessary to install this series arc system on a machine supplying other circuits, a transformer is recommended. This transformer is connected between the machine and the series arc regulator circuit, insuring perfect separation of its circuit from any others supplied from the same machine.

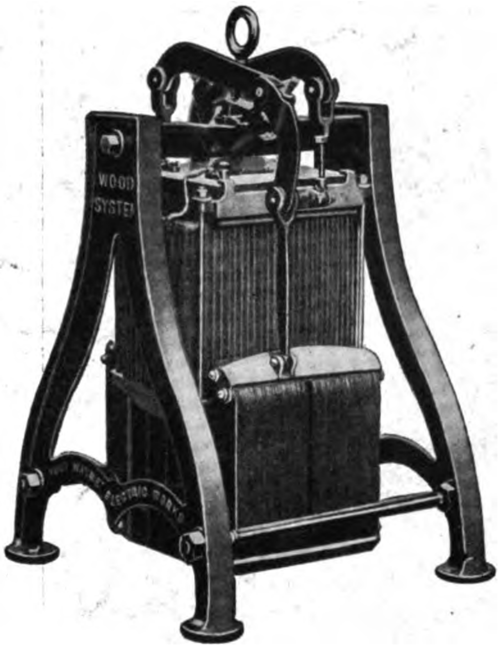


FIG. 2.—WOOD REGULATOR.

Transformers for this use are furnished with one-to-one ratio, or, if higher voltages are required, with the proper ratio to obtain the desired voltage for the arc circuit. It is frequently necessary in installing arc lighting systems to consider extensions of the system to meet the growth of the community. The Fort Wayne series alternating system is designed to take care of extensions and at the same time operate efficiently with the initial load. This is done by installing a regulator large enough to meet the maximum future demands and a transformer furnishing proper voltage to economically operate the regulator with this partial initial load. This lower voltage is obtained from a series of transformer secondary taps, by means of which the arc circuit voltage may be varied from 50 per cent of full voltage up to maximum secondary voltage in steps of such value that the circuit will always be working at approximately full load efficiency. This method of transformation will allow a lighting plant to practically double its series arc lighting output without any increase in the regulating system or transformer, simply by changing the connections on the secondary taps of the transformer, and at all times insures the highest economy and maximum power factor in the regulator circuit.

Figs. 1 and 2 show the "Wood" regulator on a stand for station installation. The knife edges are mounted on the casting supported on two A frames between which the regulator is suspended. The joints in the levers furnish means for adjusting the regulator for the proper current.

SOME EXHIBITS AT THE ST. LOUIS EXPOSITION.

THE GENERAL ELECTRIC COMPANY'S exhibit has been carefully selected, only a few examples of this company's most representative work have been shown. One of the first striking features at its space in Electricity Building is the full-sized model of the 10,000-h.p. vertical shaft generator, as built for the large Canadian power plant at Niagara Falls. The model represents the stationary armature of the machines resting on a concrete base. Inside there is a small circular room, where are photographs of the Niagara Falls electric installations of the General Electric Company. This room also serves to show lighting effects with the three different types of lamp offered by the General Electric Company, namely, the "Meridian" incandescent with prismatic reflector, the enclosed arc with concentric diffuser, and the orthochrome mercury vapor arc lamp, which is a lamp combining the light of the mercury vapor arc and incandescent filament in one lamp.

The Steinmetz mercury vapor arc lamps are exhibited for the first time, and the central tower of the exhibit is surrounded by a circle of these mercury vapor tubes. The tubes of the lamps shown in this exhibit are 16 ins. long by 1 in. in diameter. The current taken by a tube in operation is 3½ amperes operating on a direct-current circuit of 125 volts. The excess voltage above the 65 required by the lamp is taken by a steadying resistance. In the type of lamp known as the monochrome the energy used in this steadying resistance is wasted. In the orthochrome mercury vapor lamp three incandescent lamps in multiple are used as a steadying resistance and placed alongside the mercury vapor tube. The tube and incandescent lamps are all enclosed in a Holophane globe. The incandescent lamps serve to supply some of the red rays, which are entirely lacking in the mercury vapor lamp. The new luminous arc lamp using magnetite instead of carbon can also be seen in this exhibit.

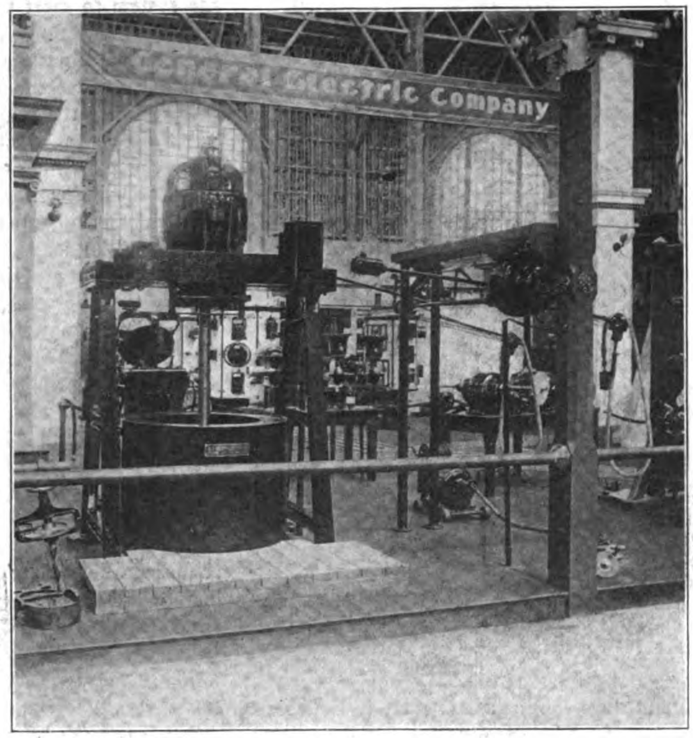
Close to the model of the largest generator ever built is one of the largest oil switches yet constructed, to break a 60,000-volt circuit. Another large piece of apparatus is a 2333-kw. transformer, built to operate with a 2300-volt low-tension and 55,000-volt high-tension voltage. This is one to be used in the Spokane (Wash.) transmission. Two coils of this transformer are shown outside the transformer to illustrate the method of construction. One of these is partially completed, and the other completed. The principle of air-cooled transformers is shown by a 250-kw. transformer of this type mounted over an air chamber, the air pressure in the chamber forcing the air through the transformer. There are also type H oil-cooled transformers.

In the railway portion of the exhibit the Sprague-General Electric multiple-unit train control system, as perfected for the Interborough Rapid Transit Company, of New York, is shown, with car bottom elevated for convenient inspection.

Five different types of railway controllers are shown. A type P 14 air compressor supplies air for cleaning machinery about the exhibit. The General Electric Company's straight air brake system for electric cars is shown for the first time. The application of induction motors to cotton mill driving is illustrated by a 100-h.p. induction motor suspended overhead and belted to four lines of shafting, two belts being run from each end of the motor shaft. In connection with this is an improved starting switch with a curve-drawing wattmeter. The application of electric motors to hoisting is shown by a double-drum Lidgerwood machine hoist electric motor and controller.

A 7-ton mining locomotive is equipped with a cable reel which automatically winds as the locomotive advances or backs up. This new cable relay allows electric locomotives to be run into new portions of the mine where trolley wires have not been installed, and at the same time does not permit the cable to become tangled up or run over by the locomotive. The cable drum contains 700 ft. of cable, and the locomotive automatically winds this up.

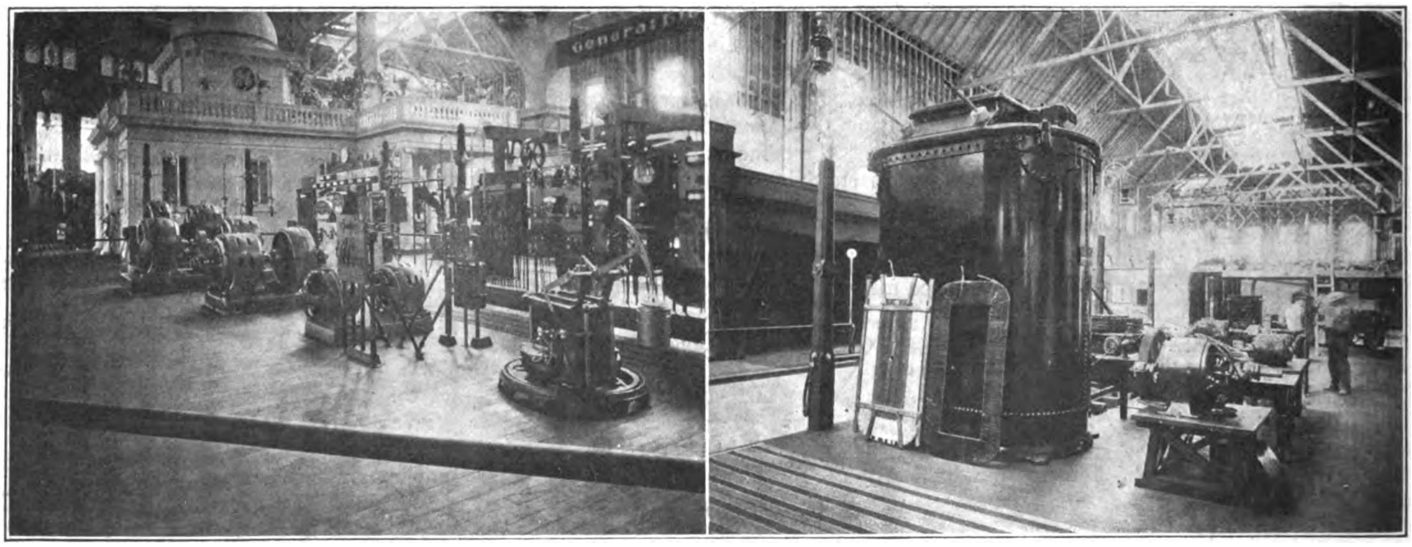
A mercury vapor rectifier with a capacity of 10 amperes, direct current is shown side by side with a motor-generator set for doing the same work, the cost of which is double that of a mercury vapor rectifier. This rectifier takes single-phase alternating current at one pair of terminals and delivers direct current at another pair. The one shown in the exhibit receives 220-volt alternating current at 60 cycles and delivers 70 volts direct current. The efficiency of the rectifier is 75 per cent. The maximum capacity of a rectifier output is 10 amperes, direct current. If more than 10 amperes is wanted, more tubes are added.



SMALL MOTOR APPLIANCES IN GENERAL ELECTRIC EXHIBIT.

CHAPMAN VALVE MFG. CO.
BOSTON, U.S.A.

ELECTRICALLY OPERATED VALVE.



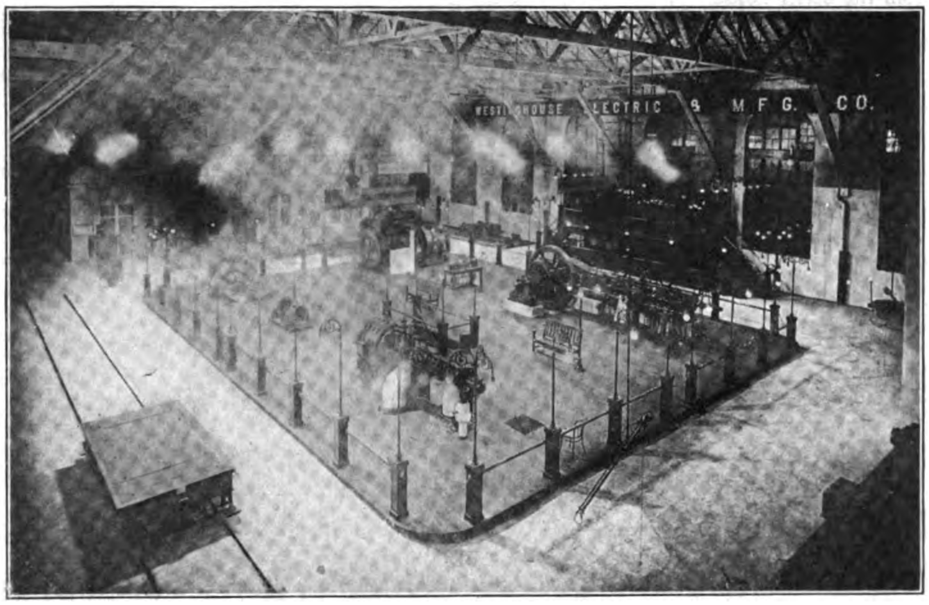
PORTIONS OF THE GENERAL ELECTRIC COMPANY'S EXHIBIT.

In one corner of the exhibit is a "tub" transformer with case removed showing the General Electric series alternating arc system. The 25 arc lamps supplied by this transformer are used about the company's exhibit. This is the system used by the Exposition for lighting the interior of the Exposition buildings, the Pike and outlying portions of the Exposition grounds. In connection with the arc lamps, the concentric diffuser is, of course, shown, and also a new white ceiling of metal, for use with arc lamps, to improve the general illumination.

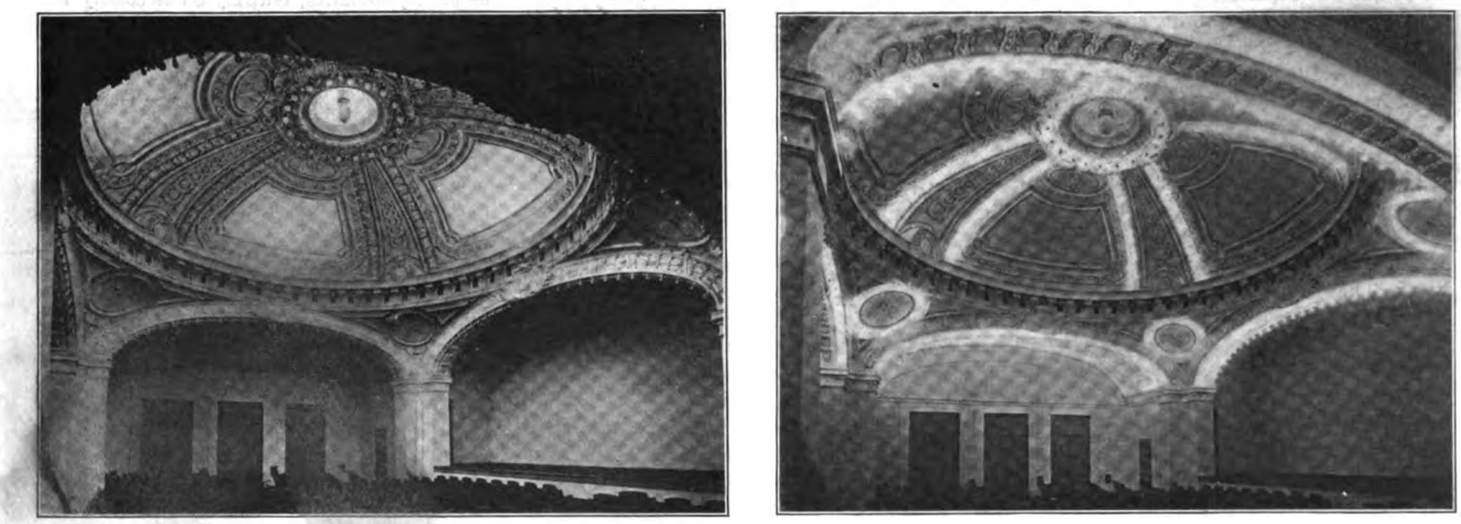
A great number of small motor appliances are shown, including a 24-in. electrically operated Chapman valve, centrifugal sugar-drying outfit with direct-connected, vertical shaft motor, portable drilling outfit with flexible shaft, alternating and direct-current sewing machine motors, electric motors, electric coffee grinder, electric buffing and grinding machines, electric meat chopper, horse-clipping and grooming machine, forge blower, job printing press, automatic envelope printing machine and a regular drill press. Voltage regulators, types TA, TD and AR, are in operation with loads which may be varied. An 18-in. searchlight electrically controlled from the main floor surmounts the tower of the company's office booth in the middle of the exhibit. The latest products of the company in wiring supplies, lamp sockets, insulators, cabinet panels, with all its classes of small work, are shown, but space does not permit a minute description of all improvements made in these small parts. An apparatus whereby a large number of condensers are charged in parallel and discharged in series so as to give one million volts is set up, and used in testing lightning arresters with a discharge similar to lightning discharge. Typical railway and lighting switchboards of several types are used in operating apparatus in the exhibit.

The exhibit of measuring instruments is especially interesting because a number of the company's new curve-drawing wattmeters and voltmeters are shown as well as the regular indicating instruments. A Thomson high-torque induction recording wattmeter is connected with a bank of lamps to show its operation on from one to sixty 4-c.p. lamps. The Thomson prepayment wattmeter can also be seen, as well as the new designs of Thomson recording wattmeter in different capacities.

THE WESTINGHOUSE EXHIBITS.—The main service plant at the Exposition which was designed and installed by Westinghouse, Church, Kerr & Co., is a notable feature of the Westinghouse exhibits which appeals, because of the commanding size of the electric generating units, each of 2000-kw. capacity, and their location in the central aisle of Machinery Hall, to practically all visitors to the Fair. The generators operate at a speed of 85 revolutions per minute and deliver a 25-cycle current at 6600 volts. Entrance to the service plant exhibit is through a large 35-foot plaster ring molded in close representation and in exact duplicate size of the stationary armature of the 5000-kw., alternating-current generators constructed for the elevated and subway train service in New York City. The total space devoted to the service electric plant in Machinery Hall, with the exciter units, condensers, cooling towers, and the 35-panel switchboard, is 26,260 square feet, and although within the Westinghouse walls at the west end of Machinery Hall, has not been laid out on elaborate lines to combine the diverse characteristics of exhibition and service, and is an exhibit plant only in so far as it is representative of modern practice at minimum cost. The various organizations associated with the Westinghouse name, which have united in representation at St. Louis under the title of the "Westinghouse Companies at Louisiana Purchase Exposition," have additional adjoining exhibit space in Machinery Hall, of 26,260 sq. ft., space in the Palace of Electricity of 10,100 sq. ft., where Baldwin-Westinghouse electric trucks and locomotives also are shown, and space in the Palace of Transportation of 3000 sq. ft., a total of 65,620 sq. ft. The Westinghouse exhibits and preparations for the reception and entertainment of visitors constitute a noteworthy feature of the industrial display at the Exposition. In Machinery Hall is the Westinghouse auditorium, which seats 350 persons, in which are displayed at regular hours through the day the biograph and mutoscope pictures of scenes in and about the various Westinghouse works in the Pittsburg district, including the first interior photography of the kind ever taken by means of the Cooper Hewitt mercury vapor lamp. Through the courtesy of the companies, this auditorium, which is rendered cool and comfortable by a ventilating system, and brilliantly lighted by the four principal systems of electric illumination, will be used throughout the Fair as a meeting place for scientific societies and technical congresses. The lighting of the hall is with the incandescent lamps of the Sawyer-Man Electric Company, Bremer arc lamps, Cooper Hewitt mercury vapor lamps, and the Nernst glowers, all of which are used extensively throughout the Westinghouse display. The Cooper Hewitt lamps are shown in the booths in Machinery Hall and in the Palace of Electricity as designed for use in general illuminating, photographing and photo-engraving. The lamps are in use on the grounds and in various exhibits, and never fail to excite comment. The most striking use of the lamp, however, is in the eight-foot tubes which are hung over the entrance to the Westinghouse auditorium and over the entrance to the Cooper Hewitt booth in the Palace of Electricity. There are in all about 10,000 Nernst glowers in use in the Exposition buildings, 6,000 of them in the Fine Arts Museum. It is interesting to recall that the first public appearance of the Nernst lamp in any considerable number was only three years ago, at the Pan-American Exposition. To-day the new lamp is playing a very prominent part in the illumination of the world's greatest exposition. On exhibition or in service the Westinghouse Companies have installed within the Exposition grounds 14,000 horse-power in generating machinery and 30,000 horse-power in other apparatus.

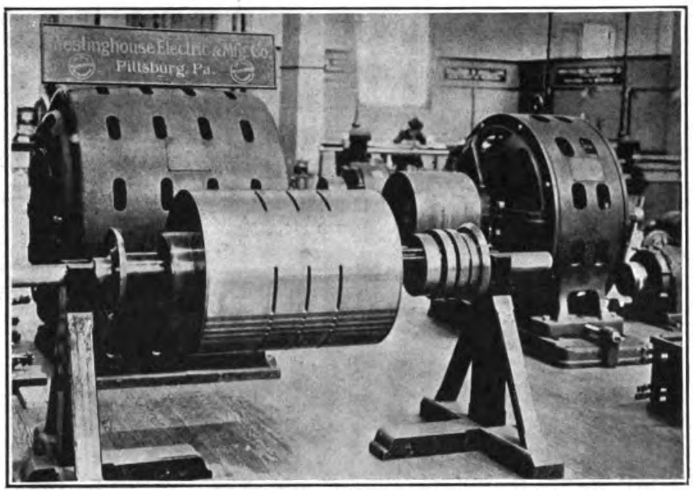


PART OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY'S EXHIBIT.



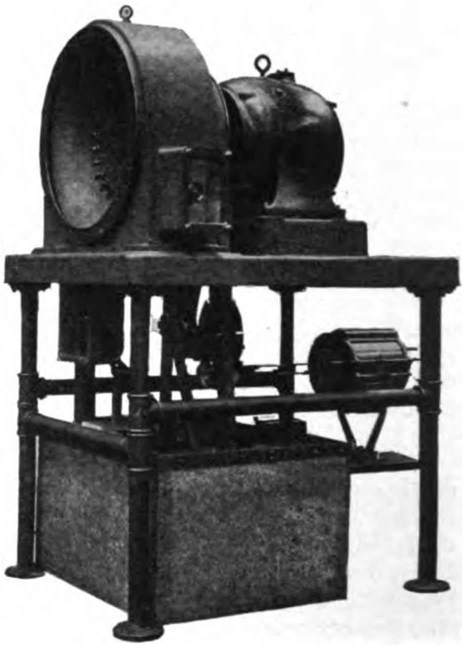
VIEWS SHOWING SUPERIORITY OF COOPER-HEWITT MERCURY VAPOR LAMPS OVER INCANDESCENT LAMPS FOR PHOTOGRAPHIC PURPOSES.

The Sawyer-Man Co.'s display of various types and sizes of its well-known incandescent lamps is in the general Westinghouse exhibit space in the Palace of Electricity. There, also, the Bryant Electric Company shows a variety of lamp sockets, receptacles, switches and other products, including details manufactured by the Perkins Electrical Switch Manufacturing Company. The R. D. Nuttall Co.'s exhibit of cut and planed gears, trolleys, trolley gears and pinions, for electric railway, mine and industrial haulage motors, is in Machinery Hall, near the Westinghouse headquarters. Steam for the electric service plant is piped from the boiler house, nearby, in which there has been installed a large battery of Babcock & Wilcox water tube boilers built into a single setting, with a total capacity of 6400 horsepower. Equipment here includes also Roney mechanical stokers at the furnaces, operated by Westinghouse standard steam engines, a complete coal conveying system furnished by the Link Belt Engineering Company, Cochrane feed water heaters, Worthington steam pumps, mechanical draft condensers, cooling towers and other apparatus to be found in a model station of the present day. The auxiliary apparatus in the electric plant includes three 80-kw., direct-current, 125-volt, direct-connected, engine-driven exciter units, two of which are sufficient to operate the entire plant and adjacent auxiliary machinery in the exhibit sections. Each of the four chief generating units receives steam from a separate line, supplied by a separate battery, the entire plant thus consisting of two sections which may be operated independently or together. The exhibit service plant, immediately west of the Companies' headquarters, is utilized to furnish power for various purposes, and includes a Westinghouse-Parsons steam turbine generating set of 400-kw. capacity, operating at a speed of 3600 r.p.m., and delivering a three-phase, 60-cycle current at a potential of 440 volts. The unit selected for exhibit is at the present time the smallest turbine unit built by the Westinghouse Machine Company. The construction of the rotating field of the generator shown in connection with the turbine on exhibit may be studied in the exhibit in the Palace of Electricity, where one of similar type is set up but not in operation. The exhibit service plant contains also a 125-h.p. vertical and a 225-h.p. horizontal gas engine, the first direct connected to standard two-wire, the second to standard three-wire, double-voltage, direct-current generators. Both single-acting and double-acting types of gas engines at present manufactured by the Westinghouse Machine Company are here represented in their latest form. An important part of the installation which is seen by few is the pumping apparatus under the beautiful Cascades in front of Festival Hall. This equipment was designed to supply 90,000 gallons of water a minute for these Cascades, by three large centrifugal pumps each driven by a 2000-h.p. induction motor. In the Palace of Electricity, the company occupies a space of over 10,000 sq. ft., including 1600 sq. ft. devoted to the display of electric trucks and locomotives constructed in conjunction with the Baldwin Locomotive Works. In the regular electrical equipment display are a 400-kw., turbine-type generator; typical generators for direct and alternating currents; for belt or direct connection; rotary converters; motor-generator sets; oil insulated and air blast transformers; direct-current and alternating-current railway motors and controllers; single and polyphase induction motors of constant and variable speeds; direct-current motors of many types, including motors for variable speed service from single and double-voltage circuits, switchboard apparatus, ammeters, voltmeters, wattmeters, synchroscopes, power factor meters, circuit breakers and switches, many of them electrically operated; portable instruments; instruments of precision; potential regulators, and innumerable other forms of auxiliary apparatus and instruments. The alternating current series wound, single-phase crane motors, similar in type and general construction to the single-phase railway motors exhibited in the Transportation Building, and the new unit switch system of multiple control are also to be seen in this section.



ROTATING FIELD OF TURBINE GENERATOR.

THE PELTON WATER WHEEL COMPANY'S exhibit, although covering a relatively small area, is very instructive. It consists of a 20-in. Pelton water wheel overhung on the shaft of a small General Electric generator and operated by water delivered in the usual manner through a needle nozzle and supplied from a centrifugal pump. The rim of the wheel at the point where the jet of water strikes the buckets is illuminated at fixed intervals by rays of light from a General Electric searchlight located beneath the wheel. The light beam is delivered into the wheel housing through a window in the bottom by a system of mirrors. Interposed between the searchlight and the water wheel is a sheet-iron disc with radial slots, the disc being revolved by means of gearing at a speed proportional to that of the wheel, so that the light passing through the rapidly moving slits illumines the wheel bucket at fixed intervals corresponding to the passage of each bucket at the point where the jet impinges. The result is that one sees the wheel apparently standing still and is able to observe the action of the water in the buckets and trace the path of the jet from the time it enters the bucket, through its reversal, to the clearance of the succeeding bucket. This apparatus makes it clear to the observer that the front lip of each bucket produces no disturbance of the water jet in entering the jet, that the water velocity is taken up on the surface of each bucket in a line vertical along the shaft center, and that the water is discharged from the sides of each pair of buckets without interference with the next succeeding pair or with the web of the wheel. No water is carried around with the wheel, the discharge occurring as soon as the water has transferred its kinetic energy to the rotating wheel. The exhibit is probably the most powerful argument in favor of the Pelton water wheel that could be made, obviating entirely all necessity for verbal argument so far as those who understand the fundamental principles of water wheel operation are concerned.



APPARATUS FOR OBSERVING WATER-WHEEL IN OPERATION.

THE DAYTON ELECTRICAL MANUFACTURING COMPANY, Dayton, Ohio, exhibits the Apple ignition apparatus. In addition are shown storage batteries, jump spark coils, contact coils, plugs, timers and magnetos made by this company. A 20-h.p. unit supplies the current for operating the exhibit and lighting a large sign. This engine is ignited by either jump spark, the touch spark or the Apple electric flame at the option of the attendant. On the switchboard a new design of ignition meter shows the number of charges taken by the engine and the number of charges ignited by each of the three systems mentioned, thus showing the comparative merit of each. On a long table are a dozen fly-wheels of various sizes operating twenty-four ignition dynamos fitted with Apple governors, which are said to maintain the speed of the generators constant regardless of the speed of the gas or gasoline engines.

THE OTTO GAS ENGINE WORKS, of Philadelphia, occupy a large space in Block 41, Aisles D and E, of Machinery Hall. The general display is consistent with the high grade of the Otto engine. There are seventeen engines for general and special work, eleven of which are fitted up and running, ranging in sizes from 2 to 140 horsepower. There are several features of more than ordinary interest, including a 40 h.p. horizontal, single-cylinder engine direct-connected to a Diehl generator, and a special electric light type of engine, fitted with a patented rotary ball governor which regulates on the "hit-and-miss" plan. The regulation of this engine is claimed to be perfect, giving a variation in voltage not exceeding 2 per cent. from full load down to but a few lights. The claim for this engine is that, being of the single-cylinder type, it requires less attention and is very much simpler in construction than an engine having a multiplication of cylinders in order to get the regulation for electric light purposes.

With this method of governing, the idle running gas consumption is said to be less than 18 per cent. of full load consumption, which, it is claimed, is more economical than the throttling method of governing or an engine having a multiplication of cylinders.

The two largest types of engines shown embody the latest features for large engine construction. They are fitted with self-starters, the method of starting being to set the engine at the point of ignition and with a hand pump deliver a charge into the cylinder; after the cylinder is charged it is cut off and a somewhat greater pressure is pumped into a vessel which is part of the starter, after which the hand lever is opened, allowing the greater pressure in the vessel to enter the engine cylinder and slowly turn the engine over, when the igniter snaps and the charge is ignited, which gives the flywheel sufficient momentum to draw in the next charge by the engine in the regular way.

All of the engines are fitted with electric igniters having both movable and stationary electrodes mounted in a phosphor bronze flange.

The marine-type, vertical, two-cylinder engine is of the standard Otto construction employed for submarine boats. Two types of pumping engines are shown, vertical and horizontal, the pump being directly geared to the engine, making a very compact design. There is also a 10-h.p. engine belted to an electric generator. The space is very brilliantly lighted by arc and incandescent lamps, which are supplied from dynamos run by engines in the exhibit space.

The company also exhibits a number of awards, gold and silver medals, which have been received at other prominent expositions; the company claims the distinction of having over a hundred gold and silver medals and numerous awards and diplomas.

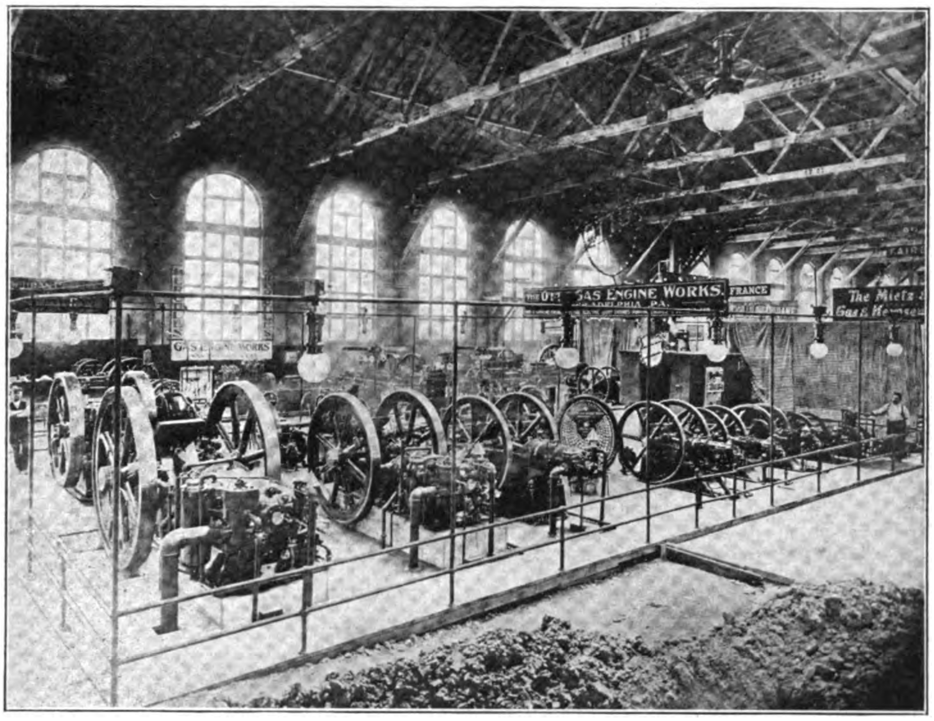


EXHIBIT OF OTTO GAS ENGINES.

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NEW BOOK.

SPANGENBERG'S STEAM AND ELECTRICAL ENGINEERING. By E. Spangenberg, Albert Uhl and E. W. Pratt. St. Louis, Mo.; George E. Zeller. Cloth; 695 pages, 5½ ins. x 8½ ins.; over 600 illustrations. Price, $3.50.

This book belongs partly to the class of catechisms which have become so familiar in steam engineering, and as its title indicates, the authors endeavor to cover both steam and electrical engineering within the one volume. The catechism form, however, is restricted to the steam engineering section. In this section the properties of steam, the different thermometers, different types of steam boiler, engines, steam gauges, injectors, pumps and heaters are explained in elementary language, and the proper care of boilers, engines and other apparatus is indicated. The steam section also contains a considerable discussion of locomotives. In the electrical section the authors start out with an explanation of the fundamental units, followed by a discussion of simple circuits, electromagnetism, magnets and the dynamo. This is followed by a chapter on the details of armature winding, one on motors and motor control, and another on measuring instruments. The authors next discuss incandescent and arc lamps, storage batteries, alternating currents and apparatus, wiring calculations and the installation and repair of electrical apparatus, closing with a list of probable troubles and the remedies for them. This section is followed by a short one on compressed air apparatus, another on gas and gasoline engines, one on mechanical refrigeration, and still another on hydraulic elevators. The book closes with a brief chapter on machine shop repair work, which also contains a list of workshop recipes and useful tables and formulas.

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A UNIQUE POWER-PLANT SALE.

Central station managers seeking an opportunity to purchase advantageously equipment for a power plant will be apt to find it in the disposal of the service station of the Louisiana Purchase Exposition. This plant is described in another part of this issue. It has a capacity of about 14,000 horsepower and was designed and installed by Westinghouse, Church, Kerr & Co., to illustrate the best practice in plants of such size. The equipment must be removed at the close of the Exposition and will be sold in whole or in part for immediate delivery when the fair is over.

The equipment was all new when installed and has been used just enough to insure the good running condition of all parts. There are four vertical cross compound engines, with 38-in. and 76-in. cylinders, 54-in. stroke, fitted with Monarch safety stops. Two of these engines are direct-connected to General Electric 2000-k.w. generators and two of them to Westinghouse generators of the same capacity; these are 3-phase, 25-cycle, 6600-volt machines of the revolving field pattern. Steam is furnished by sixteen 400-h.p. Babcock & Wilcox boilers equipped with Roney stokers.

The auxiliary apparatus includes a Worthington Admiralty pattern boiler feed pump, two Worthington compound feed pumps, two Cochrane feed-water heaters and purifiers, four 14-ft. mechanical draft fans, each driven by a Chandler & Taylor automatic engine, two Worthington elevated jet condensers, a Worthington vertical dry vacuum pump and two Worthington horizontal flywheel dry vacuum pumps, sixteen Seymour fans driven by a Westinghouse compound engine, three Worthington Volute centrifugal pumps, three Westinghouse 80-kw. exciter units, a switchboard and all its appurtenances, and a 40-ton, 80-ft., 3-motor, Niles-Bement-Pond crane. In addition there is a large amount of steam and water piping, valves, gauges, traps and apparatus used in the Holly system for returning condensed water to the boilers. So many conjectures have been made concerning the disposition of this plant after the close of the Exposition that we are glad to be able to make this announcement.

NOTES FROM THE CONTRACTORS' CONVENTION.

There was in evidence at the National Contractors' Convention held at St. Louis a contingent of manufacturers and representatives worthy the National Electric Light Conventions in the best days of the "Exhibit" feature.

The Nernst Lamp Company: A. K. Hurst, St. Louis.

V. C. Gilpin was on hand to discuss DeVeau telephones.

American Carbon & Battery Company, St. Louis: Mr. Henry Wrape.

American Conduit Manufacturing Company, Pittsburg, C. A. Flack.

The Phelps Company, Detroit: Messrs. W. E. Phelps and J. W. Phelps.

Dayton Electrical Manufacturing Company, Dayton, Ohio: Mr. G. Apple.

The Benjamin Electric Manufacturing Company, Chicago, Ill., B. B. Benjamin.

American Electrical Heater Company, Detroit: Mr. B. H. Scranton, president.

Habirshaw wires had as sponsor Manager J. B. Olson, of the New York Office.

Mr. Robert Garland represented the Safety Armourite Company, of Pittsburg.

W. H. Morton, of Johnson & Morton, Utica, N. Y., made many new friends.

Mr. W. S. Sissons, of Providence, was there to talk the merits of D. & W. fuses.

Faries Manufacturing Company, of Decatur, Ill., was represented by Dr. W. J. Grady.

"Diamond H" switches were spoken for by Mr. W. P. Crockett, of the Chicago office.

Mr. Charles E. Lee came from Boston to represent the Electric Gas Lighting Company.

The Electric Appliance Company, of Chicago, sent its very best—Mr. William W. Lowe.

Pass & Seymour were represented by Messrs. Salsbury and Brooks, of the Syracuse office.

The Pardridge Shade & Reflector Company, Chicago, was represented by Mr. J. S. Pardridge.

W. R. Ostrander & Company sent Messrs. Vaughan and Monk to look after their interests.

Hart & Hegeman Manufacturing Company, Hartford: Mgr. George S. Searing, of the Chicago office.

Franklin Electric Manufacturing Company, Hartford and New York: Mr. Charles I. Hills, president.

Bossert Electric Construction Company, Utica, N. Y., had President Bossert himself as representative.

The Sprague Electric Company had the Greenfield conduit well spoken for by Mr. Alex. Henderson.

Gould Storage Batteries were ably championed by Messrs. W. W. Donaldson, E. L. Draffen and A. S. Hubbard.

H. B. Coho, New York representative of the Keystone Electric Company, Erie, Pa., was on hand in the interests of his company.

Condit Electrical Manufacturing Company, Boston, was represented by Mr. Fred W. Nason, who explained the merits of Eden circuit-breakers.

The Seidler-Miner Company, of Detroit, had Mr. Frank J. Miner in attendance. Mr. Miner has just recovered from a very serious illness.

Mr. Hugo Reisinger, in addition to his duties as World's Fair Commissioner and Juror, had time to make known the merits of "Electra" carbons.

The Ewing-Merkle Electric Company, St. Louis: Messrs. A. P. Ewing, W. S. Merkle, W. G. Brown, A. L. Philo, T. P. Gleeson, W. G. Sims, R. L. Faries.

The Wagner Electric Manufacturing Company, St. Louis, was represented by Mr. W. A. Layman and various members of its engineering and sales departments.

Manhattan Electrical Supply Company had two sturdy representatives in Messrs. McDowell and Pierce, from the New York and Chicago offices respectively.

Of the Missouri American Electric Company, St. Louis, Mo., Mr. A. W. Miller, president, and Mr. George P. McDowell, vice-president, remained in St. Louis.

The Warren Electric Manufacturing Company, Sandusky, Ohio, was represented by the staff of the Wesco Supply Company, the local agent for the Warren alternators.

"Flexduct" was ably represented by Messrs. C. E. Corrigan, Harry Osburn and C. B. Roulet. Mr. Bennett, Chicago representative, was also in attendance as an understudy.

The Locke Insulator Manufacturing Company, Victor, N. Y., was represented by the staff of the Wesco Supply Company, which company is the local agent for the Locke insulators.

The Columbia Incandescent Lamp Company, St. Louis, Mo., entertained at its new factory. Mr. Garrison, president of this company, and associates were "at home" during the entire week.

The Schaeffer & Budenberg Manufacturing Company had Mr. A. L. Portong in attendance, and its exhibit of steam specialties at the Fair attracted much interest among the delegates.

Crocker-Wheeler Company, Ampere, N. J., was represented by its president Dr. Schuyler S. Wheeler, Messrs. Gano S. Dunn and Rodman Gilder and other members of the engineering and commercial departments.

The Dale Company, New York, was represented by John H. Dale and O. J. Bryan, from New York, who distributed a handsome souvenir of their new wireless cluster that has met with such marked success.

John A. Roebling's Sons Company sent two able delegates in Frank W. Harrington and G. W. Swan, and while Mr. H. L. Shippy could not be there, he sent a neat little characteristic souvenir in the shape of a corkscrew made of Roebling wire.

Wesco Supply Company, St. Louis, was naturally strong in its representation, Messrs. Roger Scudder and A. L. Scudder, J. E. Ecoff, N. J. Roth, F. S. Weimeyer, A. A. Marr, George F. Schminke, V. E. Raggio, R. S. Waldfield, J. W. Krueger and G. W. Cooper being almost constantly on hand.

The American Circular Loom Company was kept constantly in mind through the strenuous efforts of Messrs. H. B. Kirkland, T. H. Bibber and Thomas G. Grier. This was Mr. Kirkland's first convention since his serious illness of last spring, and he was congratulated on all sides on regaining his "old form."

The American Diesel Engine Company, New York, was represented by Mr. Norman McCarthy, sales manager. The sixty-thousand-dollar installation of the Diesel oil-burning engines made by this company for lighting the Tyrolean Alps on the Exposition grounds attracted much attention from visiting engineers.

OBITUARY.

J. B. RAMP, of the Murray Iron Works, Burlington, Ia., died recently at the age of seventy-four years. Mr. Ramp was for nearly twenty-five years superintendent of the foundry of the Murray Iron Works and was held in the highest esteem by both his employers and his subordinates. He was a native of New York City and was a Civil War veteran.

PHILIP W. MOEN, formerly of the Washburn & Moen Manufacturing Company, Worcester, Mass., died on September 12 from a stroke of apoplexy. Mr. Moen was one of the pioneers in the manufacture of wires for electric light and power circuits. At the time of his death he was a director of the Worcester Consolidated Street Railway Company and the Boston & Worcester Street Railway Company.

RICHARD S. WARNING, a founder of the Standard Underground Cable Company, died recently at Elmira, N. Y. Mr. Waring was born in Saratoga County, N. Y., in 1833 and went to Pittsburg, Pa., when he was about twenty-three years of age. After widely varied and successful experiences in other lines of business, Mr. Waring organized the Standard Underground Cable Company in 1882, and although there was at that time practically no market for underground cables in this country he spent money liberally in perfecting the cable system and methods of manufacture which have made the company one of the most successful in the world. In 1887 Mr. Waring organized in England the Fowler-Waring Cables Company, Ltd., for the manufacture of the same line of cables then being turned out by the American company. About five years ago he was obliged to retire from active business on account of failing health and had since resided at Elmira.

PERSONAL.

DR. F. A. C. PERRINE, formerly vice-president of the Stanley Electric Manufacturing Company, Pittsfield, Mass., has entered the field of consulting engineering, with headquarters at 49 Wall Street, New York.

MR. F. V. HENSHAW, for several years past a prominent member of the engineering staff of the Crocker-Wheeler Company, has resigned his position with that company and is now taking a well-earned rest before engaging in other work.

MR. BUDD FRANKENFIELD has resigned his position on the engineering staff of the Nernst Lamp Company to accept a position in the engineering department of the Bullock Electric & Manufacturing Company, Norwood, Ohio.

MR. R. C. ROUTLEDGE, formerly connected with the firm of Thomas F. Smith & Co., New York, has been placed in charge of the contracting department of the H. W. Johns-Manville Company, this city, and will give his personal attention to all inquiries and orders.

MR. J. A. GORDON, of the International Telephone Manufacturing Company, Chicago, has been put in charge of the new construction work of the Public Service telephone system in the town of Neepawa, Manitoba, which system is being practically doubled in capacity.

MR. L. P. HAMMOND has resigned his position as manager of the Denver branch office of the Crocker-Wheeler Company to accept the sales managership of the Denver Engineering Works Company. Mr. Hammond's headquarters will be at the Denver office of the company.

MR. ARTHUR HARTWELL, who for a number of years has been general sales manager of the Westinghouse Electric & Manufacturing Company, has resigned that position to accept the position of general manager of the Sterling Varnish Company of Pittsburg.

MR. O. H. ENSIGN, who has been prominently connected with the Los Angeles Edison Electric Company, has resigned his position there to accept one as consulting engineer with the United States Reclamation Service. Mr. Ensign will have supervision of all of the electrical and hydraulic power development work of the Reclamation Service and will have his headquarers in Los Angeles.

MR. EDWARD E. GOUDEY, formerly general manager of the Goudey-McLean Company, who recently resigned that position to take a partnership interest in the engineering firm of B. F. Bell & Company, has since joined in the organization of the Bell Engineering & Construction Company to succeed the firm of B. F. Bell & Company in the business of consulting and contracting engineering.

MR. G. STANLEY RICHMOND, recently a member of the engineering staff of the Interborough Railway Company, has established headquarters in the Morton Building, New York, where he will engage in consulting electrical engineering. Mr. Richmond was in charge of the recent inspection of the ground return systems of the Richmond (Va.) electric railways. He will make a specialty of investigations and reports in this particular field and also upon underground distributing systems and fuel testing departments in power houses and central stations.

TRADE PUBLICATIONS.

BLAST FURNACE PLANTS. The William D. Pollock Company, Youngstown, Ohio.—A superbly executed book, containing half-tone illustrations of a number of modern blast furnaces which have been erected by this company and also of some of the chief detail apparatus.

ELECTRIC HOISTS AND WINCHES. C. W. Hunt Company, West New Brighton, N. Y.—Catalogue No. 046, containing a detailed description of the Hunt electric hoists, winches and capstans, in connection with which both direct-current and alternating-current motors are used.

RUST WATER TUBE BOILERS. The Rust Boiler Company, Pittsburg, Pa.—A handsome catalogue of standard size containing a well-illustrated description of the Rust boiler construction, some remarks on the selection of boilers and a discussion of types different from the Rust boiler.

TELPHERAGE FOR COAL HANDLING IN POWER STATIONS. United Telpherage Company, Westfield, N. J.—This is circular No. 52 describing the Telpherage Company's system for handling coal in gas works, electric light and power stations and other large manufacturing establishments.

PUMPING MACHINERY AT ST. LOUIS. International Steam Pump Company, New York.—This is a reprint of an article published in the *Iron Age* on the pumping and air-compressing machinery at the Exposition, this machinery, it is scarcely necessary to say, being of the Worthington manufacture.

DIRECT-CURRENT TURBINE-DYNAMOS. De Laval Steam Turbine Company, Trenton, N. J.—This is bulletin No. 2, containing an illustrated detailed description of the turbine-dynamo outfits built by this company in sizes ranging from 7 to 300 horse-power for direct-current service. The company has also issued bulletin No. 6 calling attention to De Laval turbine blowers.

A. B. C. STEAM ENGINES. American Blower Company, Detroit, Mich.—Bulletins Nos. 162, 163 and 164, devoted respectively to Type F vertical engines, Types B and C vertical engines and Type I horizontal engines. The Type F engines are built in three styles, one with automatic shaft governor, another with the ordinary flyball throttling governor, and the third without any governor for direct-connection to blower fans. Types B and C are all equipped with automatic governors of the Rites design and intended primarily for direct-connection to dynamos. The Type I engine is built in three styles corresponding to those of Type F.

OPINIONS OF THE AUTOMATIC TELEPHONE. Automatic Electric Company, Chicago.—Two attractively executed pamphlets, one containing a large number of opinions concerning the service of the automatic exchange in Grand Rapids, Mich., and another containing similar opinions concerning the service of the automatic exchange in Portland, Me. The testimonials are signed by prominent citizens in both places and all are extremely complimentary. The annual report of the secretary of the Grand Rapids company has been published in pamphlet form by the Automatic Company and makes an excellent showing for the automatic exchange in Grand Rapids.

AIR BRAKE TESTING. The Westinghouse Air Brake Company, Wilmerding, Pa.—This is a splendidly executed book of 323 pages, containing a vast amount of highly valuable information on the subject of air brakes and air brake tests. Beginning with a short chapter on the growth of car braking, the book presents most complete reports of the Galton-Westinghouse tests made in England in 1878, Paris and Lyons tests made in 1879, the Burlington Railway trials made in 1886 and 1887, and so on throughout a long list of important tests of air brakes on steam railroads, the latest being those made last year on the Central Railroad of New Jersey at Atsion Station. All of the trials were competitive and in all of them the Westinghouse system made the best showing.

BUSINESS NEWS.

ELECTRO DYNAMIC COMPANY, Philadelphia, Pa., has removed its manufacturing headquarters to Bayonne, N. J., where a new large factory, well equipped for the production of dynamos, motors and other apparatus, has been established. The local address is corner of Avenue A and North Street.

MACHADO & ROLLER, New York, have been appointed Eastern sales agents for the dynamos and motors built by the Fidelity Electric Company, Lancaster, Pa. The Fidelity Electric Company makes a specialty of small machines, including special polishing and buffing motors, vertical type motors, small rotary converters, etc. Machado & Roller will carry a complete line of the representative sizes in stock in New York.

THE MACON-EVANS VARNISH COMPANY has been organized in Pittsburg for the manufacture of high-grade varnishes and insulating materials, with main office and works at Esplen Borough. L. S. Macon is president of the company and Cadwallader Evans, Jr., is secretary and general manager. Mr. Macon was for a number of years secretary of the Sterling Varnish Company; Mr. Evans was formerly with the Oliver Iron & Steel Company, of Pittsburg.

GOULD STORAGE BATTERY COMPANY, New York, reports among recent contracts the following: City & Suburban Railway Company, Portland, Ore., a 280-cell battery and regulating booster; Edison Electrical Illuminating Company, Topeka, Kan., a 280 cells battery and regulating booster; Leominster, Shirley & Ayer Street Railway Company, Shirley, Mass., 224 cells; Corporation of the Town of Port Arthur, Canada, 240 cells. The company has also installed a large number of batteries in isolated plants recently.

THE SPRAGUE ELECTRIC COMPANY, New York, is enjoying an excellent business in electrical hoisting apparatus. Among recent orders are eight electric hoisting outfits to be used in handling castings in the construction of the new Pennsylvania Railroad tunnel in this city, thirteen hoists for the Pennsylvania Railroad car wheel foundry at Altoona, and twenty for the new works of the International Steam Pump Company, Harririson, N. J. The company's flexible metallic conduit is used throughout the cars of the subway system in New York for the lighting circuits. This conduit, it may be remembered, is a flexible one consisting of steel tapes wound spirally into tubular form.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, which was awarded the contract last year for the United States Navy supply of incandescent lamps aggregating approximately 160,000 lamps, announces that it has not only filled the rigid requirements of the contract, but has not had a single lamp rejected as the result of life tests or drop in candle-power tests, and the number rejected on photometer readings is remarkably small. The original contract has been supplemented by additional orders from the government, so that the number of lamps actually supplied will aggregate about 200,000. The company is still filling government orders satisfactorily, and is fully equipped to handle any large requirements on close specifications.

MARINETTE GAS ENGINE COMPANY, Chicago Heights, Ill., is now well established in its new factory plant, which is favorably located, large, roomy, well lighted and excellently equipped. The company has recently made some important shipments of gas engines for electric light service, including several engines direct-connected to generators which were sent to Lisbon, Portugal. Among some of the larger installations are three 85-h.p. direct-connected engines in the Pittsburg Post Building, Pittsburg, Pa.; three 125-h.p. direct-connected outfits in the Pittsburg Exchange Building, and nine 85-h.p. direct-connected units in the Diamond Light & Power Company's plant. The company has recently secured a contract from the United States Government for the installation of a 75-h.p. engine for direct connection to a generator at Fort Hamilton, N. Y.

DODGE & DAY, of Philadelphia, Pa., have been commissioned by Alexander Brothers, of that city, to take charge of the electrical installations in the property recently acquired by them. A generator will be required, several motors, switchboard, line-shafting, wiring, etc. These engineers have just placed orders for two horizontal high-speed engines of 160 and 240-h.p. respectively with Ames Iron Works, Oswego, N. Y.; 600-h.p. of tubular boilers with Ervien & Company, Philadelphia, and 100 and 150-kw. generators with Crocker-Wheeler Company for the Victor Talking Machine Company's new plant in Camden, N. J. Other commissions of this firm are the purchase and installation of a night set for the new plant of the Jeanesville Iron Works Company, Hazleton, Pa., and the running of transmission line to Jeanesville (a distance of two miles) to furnish illumination for the town and residences; a heating system for residence of James C. Haydon, Janesville, Pa.; ten automobile garage and electrical equipment thereof for the Link-Belt Engineering Company, Nicetown, Pa.

THE REEVES ENGINE COMPANY, Trenton, N. J., and New York, has just published a most interesting bulletin containing the results of tests made by Professors Carpenter and Diederichs at Sibley College, Cornell, with a Reeves simple engine having a cylinder 15 inches diameter by 14 inches stroke. The average initial steam pressure of the various tests was 114 pounds. Running non-condensing the engine showed a consumption of 40 pounds of dry steam per hour per indicated horse-power at 37 horse-power, 30 pounds at about 77 horse-power and 28 pounds at 120 horse-power. The mechanical efficiency was 65% at 35 horse-power, 80% at 75 horse-power and 90% at 122 horse-power. Running condensing the steam per indicated horse-power-hour was 35 pounds at 27 horse-power, 27 pounds at 80 horse-power, about 26 at 120 horse-power and the same at 140. The steam per hour per developed horse-power condensing was 44 pounds at 25 horse-power, 28 pounds at 100 horse-power and 27½ at 140 horse-power, the mechanical efficiency being 95% at 133 horse-power (developed). When running condensing the vacuum was about 23½ inches.

THE NEW ENGLAND MOTOR COMPANY, Lowell, Mass., is bringing out a line of storage batteries for stationary and vehicle work, which, while not exhibiting anything startlingly novel in their construction, still show features of merit. The plates are of the pasted type, the oxides being applied to moulded grids in the usual manner. The negative plates, after being formed, are subjected to considerable pressure, so as to consolidate the spongy lead and make it more adhesive. The positive grids are oxidized before being pasted. In the vehicle battery cells grooved wooden separators are used. The wood is treated by a special process to prevent the formation of acetic acid or gum-dextrin. The details of this process are not given, but it has been the result of considerable experimentation on the part of the company. The New England Motor Company has been building these batteries for some two and a half years and using them on automobiles and launches with a view to thoroughly testing their efficiency and capability of withstanding hard usage. The results have more than come up to the anticipations. While no special effort has been made to obtain large output per pound in the vehicle cells, the performance is very creditable. The 150-ampere-hour cell for 4-hour rate weighs complete 28 lbs., and this is said to be lighter than any other cell of equal capacity on the market, being an output of 10 watts per pound of complete cell at the 4-hour rate. The grids, it is stated, are of such a form as to give great mechanical rigidity. Special machinery has been designed for the production of the plates, and prompt shipments can be made in almost any quantities. The company will, upon application, be pleased to furnish bulletins descriptive of these storage batteries.

CENTRAL STATION NEWS

ALABAMA.

SHEFFIELD.—Mr. George M. Morris is superintendent of the plant of the Sheffield Company.

MOBILE.—The Gulf Electric Company has filed articles of incorporation with the Secretary of State. The capital stock is $70,000 and the incorporators are J. H. Wilson, C. W. Chase, R. W. Jones and Sidney Lewenstein.

GADSDEN.—The Etowah Light & Power Company, which is building an extensive electric plant, has let the contracts for the operating machinery and other equipment. Capt. W. P. Lay, the owner of the company, states that between 500 and 800 horse-power will be transmitted to this city for lighting and power purposes.

ARIZONA.

GLOBE.—Mr. Charles M. Clark, of the Globe Power Company, announces that the project of establishing an electric power plant for this city and the adjacent mining camps will soon be developed in accordance with the original plans. The company has received from the Government the necessary grants of rights-of-way for its canal, transmission lines, etc. The company has already expended about $30,000 in surveys and preliminary work, and it is estimated that the cost of constructing and installing the plant will approximate $1,200,000. The minimum capacity of the plant when completed will be 6000 horse-power. The construction work includes one tunnel 7657 feet long and about eight miles of small tunnels, ditches and flumes.

ARKANSAS.

BOONEVILLE.—H. G. Sadler & Company have been granted a franchise for the establishment of an electric light plant.

FORDYCE.—Mr. J. M. Covey is superintendent and chief electrician of the Fordyce Light & Water Company, which also furnishes lighting current to Kingsland.

HARRISBURG.—It is reported that the business men of this city have secured a subscription of $4000 for the purpose of establishing water works and an electric plant.

THORNTON.—The Pine Bluff City Electric Company and the Stout-Greer Lumber Company, of Thornton, are said to have secured the contract for the installation of an electric light plant at Thornton.

FORT SMITH.—The Fort Smith Light & Traction Company has appointed H. M. Byllesby & Company, of Chicago, engineers to undertake the work of extending and improving its electric light, gas and power plant; extensions will also be made to the street railway system. The following are the present officers of the company: President, W. R. Abbott; vice-president, George T. Sparks; secretary and treasurer, R. G. Hunt; superintendent, G. H. Wilmarth; chief engineer, L. Robertson; chief electrician, J. F. Johnson.

CALIFORNIA.

HEALDSBURG.—It is necessary to readvertise for bids for the new machinery required by the increased demands on the power plant, as the contracts formerly awarded were not advertised for the required period.

FRESNO.—Messrs. W. M. Spencer and J. A. Stroud, of Oakland, are said to be interested with Fresno capitalists in a proposition to generate power near Tehipite Dome for use in Fresno and vicinity. They have organized under the name of the Tehipite Dome Power Company.

WINTERS.—Mr. E. D. N. Lehe, manager of the Dixon Electric Power & Water Company, of Dixon, this State, announces that preliminary arrangements have been made for the installation of an electric light and power plant in this city. He has lately completed the installation of the several power plants on the banks of Putah Creek, the last of which is within about six miles of Winters.

SAN FRANCISCO.—A representative of the California Gas & Electric Corporation informs us that the newspaper reports of the recent accident to the pipe line near the electric power station were greatly exaggerated. According to this authority, the damage consisted of the breaking of a length of pipe near the manifold, and this was repaired in three days at a cost not exceeding $3000; no injury was done to the power house.

LOS ANGELES.—The Edison Electric Company reports that it is now constructing a steel pole line from the plant at Santa Monica to connect that portion of its system originally known as the Edison System with the transmission system of what was formerly the United Electric Gas & Power Company. This connecting link covers a distance of some thirteen miles and joins the company's Los Angeles steam station No. 3 with the sub-station in course of construction at Inglewood.

SAN FRANCISCO.—Mr. H. W. Goode, president of the Portland General Electric Company, was chosen president of the Pacific Coast Electrical Association at the eighth annual convention held recently at Monterey. The association's constitution and by-laws were amended so as to permit corporations and individuals engaged in the distribution and generation of electric power to become members. Heretofore the membership had been limited to those engaged in the actual transmission of electric power to a distance.

REDDING.—Another power plant is projected in Shasta County to transmit current to Redding and other points. Mr. J. E. Frick, of Berkeley, who has filed on 40,000 inches of water to be taken from Rising River and Crystal Lake at a point six miles east of Redding, states that the capitalists who are behind him will form a company and install a power plant which will transmit electricity down the Sacramento Valley. The above-mentioned sources of water are also tributary to Hat Creek, from which the Shasta Power Company expects to divert water for its projected plant. It is said that an extensive transmission system will be constructed.

COLORADO.

GEORGETOWN.—The United Light & Power Company is building ten miles of transmission line which will carry current at 10,000 volts.

MANCOS.—The Mancos Electric Light Company, which began operations here in February of this year, is owned and operated by Mr. John Pinyan, who is manager and superintendent of the plant.

DURANGO.—The Durango Light & Power Company is installing new condensing machinery and will shortly add a 250-kw., 2200-volt, 60-cycle, single-phase alternator which will enable it to operate an alternating-current day circuit.

DENVER.—Mr. George D. James, civil and mining engineer, of this city, representing Eastern capital, has several surveying parties in the field for the purpose of gathering accurate data in Colorado, Utah, New Mexico, Arizona and California as to the feasibility of generating electric power from the facilities afforded by the largest rivers traversing those States and Territories, the principal streams under consideration being the Colorado, Green, Grand, Arkansas, Rio Grande, South Platte, Pecos and Gila rivers and their tributaries. It is proposed to furnish electricity to various mining camps and to supply to other sections water for irrigation and domestic purposes.

CONNECTICUT.

WINDSOR LOCKS.—Control of the Windsor Locks Electric Lighting Company has been acquired by Thomas C. Perkins, of Hartford, who recently disposed of the Mystic Electric Light Company. Mr. Perkins will take possession of the property about January 1 and will proceed to greatly enlarge and improve the plant and increase the water power in order to furnish a day service for light manufacturing; at present current is supplied for lighting purposes only.

NORFOLK.—The Norfolk Electric Light & Power Company has leased its plant in West Norfolk to the recently incorporated Canaan Company and the new company has taken possession. The streets of Canaan, which have been in darkness for the past three months, are being lighted by the Norfolk plant. Norfolk's lights will be furnished at the rate of $15 a year as at present. It is understood that the plant is to be remodeled and enlarged and will operate both day and night circuits.

FLORIDA.

MILTON.—The Milton Electric Light Company has been granted a franchise to erect and maintain poles and wires for the distribution of electricity for power and lighting purposes. Construction work is to begin within five months.

JACKSONVILLE.—Superintendent R. N. Ellis, of the city electric light plant, has been requested to submit an estimate of what extensions will be necessary in the electric lighting, water works and sewer systems in order to meet the demands of the city for the next ten years.

GEORGIA.

NEWNAN.—Reports state that it is proposed to either construct or purchase an electric light plant, and that a special election will be held to decide whether or not $20,000 bonds shall be issued for that purpose.

THOMASVILLE.—The Mayor and Council have entered a protest, with other citizens, against a bill introduced in the State Senate providing for ownership of lighting plants by municipalities and making compulsory the purchase of existing plants.

IDAHO.

IDAHO FALLS.—It is reported that the Idaho Power & Transportation Company will construct a power plant on Snake River ten miles south of here.

POCATELLO.—Mr. William S. Cone is now superintendent of the American Falls Power, Light & Water Company's plant in this city. The company also lights Blackfoot, American Falls and Rexburg.

ILLINOIS.

CANTON.—The People's Gas & Electric Light Company expects in another year to change over to a 60-cycle, direct-current system.

CHICAGO.—Mr. J. F. Foster is now superintendent of the lighting plant operated by the South Park Commissioners at 57th Street and Cottage Grove Avenue.

FAIRBURY.—Improvements are being made in the equipment of the plant of the Fairbury Electric Light, Heat & Power Company, which include the installation of a 120-kw. generator.

CHICAGO.—The incorporation of the Madison Electric Company is reported. Among the incorporators are Messrs. E. J. Ryan and John Felker. The company's capital is $2500.

MOUND CITY.—The Mound City Water, Light, Power, Heat & Manufacturing Company has completed the erection of its new boiler house and the installation of four new boilers therein. The equipment is to be still further increased next year by the addition of a new engine.

MEREDOSIA.—Messrs. C. M. Skinner, J. W. Skinner and T. D. Beeley have filed articles of incorporation for the Meredosia Light, Heat & Water Company. The company is capitalized at $20,000 and was organized for the purpose of operating a heat, light and power plant.

EAST ST. LOUIS.—Articles of incorporation have been filed by the Illinois Illuminating Company, having a capital stock of $50,000. Messrs. C. E. Harris, George F. McNulty and E. G. Bruckmann are the incorporators. The corporation is to furnish light, heat and power for East St. Louis, St. Clair and Madison counties.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

PARIS.—The Paris Gas, Light & Coke Company has been absorbed by the Paris Gas & Electric Company, which recently filed articles of incorporation with a capital of $150,000. The officers of the latter company are: President, A. A. Boyd, of Michigan City, Ind.; vice-president, W. J. Hunter, Paris; secretary, Frank Garretson, Michigan City; treasurer, J. E. Parrish, of this city. The gas, heating and electric light plants will be remodelled and improved at once.

HAMILTON.—The Hamilton Light & Power Company, just organized, has secured the contract for the city lighting, current being supplied to 17 2000-c.p. city arc lights on a moonlight schedule and to 500 16-c.p. commercial incandescents, the latter receiving a 24-hour service. The company has not as yet its own power station, power being obtained from the Keokuk Light & Power Company, of Keokuk, Iowa. The capital stock is $10,000 and the officers are: President, R. R. Wallace; vice-president, R. D. Manson; secretary, treasurer and manager, J. A. Gordon.

EFFINGHAM.—The Effingham Electric Light & Power Company announces its intention to entirely rebuild its plant within the next six months. The plans have not been fully developed yet, but they include an alternating-current generator of 225 horse-power capacity, a Corliss engine, boilers, a superheater, condenser and transformer, also from 56 to 60 500-volt alternating-current series lamps.

INDIANA.

LOGANSPORT.—The city has appropriated $30,000 to be spent in improving the lighting plant here.

INDIANAPOLIS.—A franchise for lighting the downtown streets of the city has been granted to the Merchants' Heat & Light Company.

ROCKVILLE.—Mr. E. G. Lanning has been superintendent of the Rockville Electric Light Works since June 1, having succeeded Mr. E. Newkirk.

LAFAYETTE.—The Merchants' Electric Light Association, of this city, has placed an order for a new 150-kw. alternator to be installed at its electric light plant.

NEW HARMONY.—The city has purchased the plant of the New Harmony Electric Light Company, in consideration of $7000, and appointed Mr. Thomas J. Phillips superintendent and general manager.

LOGANSPORT.—A large electric power plant is to be erected in this city by Denis Uhl and others at a cost of $150,000. The plant will be operated by water power, necessitating the construction of a dam in Eel River.

TERRE HAUTE.—The city's present contract with the Terre Haute Electric Company expires February 15, 1905, and the council has instructed the Board of Public Works to advertise at once for bids for a new electric lighting contract.

IOWA.

ST. ANSGAR.—Two new 85-h.p. boilers are to be installed soon in the lighting plant here.

WEST POINT.—The citizens have voted for the establishment of a municipal lighting plant at an estimated cost of $4000.

FARMINGTON.—Mr. Charles Cleave is manager and superintendent of the Farmington municipal electric lighting plant. It has been decided to install new arc lamps for the street lighting.

KANSAS.

COLUMBUS.—The Columbus Electric Company announces that it is preparing to embark in the steam heating business in a small way. The plans will be perfected shortly.

TOPEKA.—The Edison Electric Illuminating Company is making a one-story brick addition to its engine house. The building is to cost $6000 and will be completed by October 15.

KINSLEY.—Mr. H. P. Ketelson, proprietor of the electric light plant of this place, writes that the number of lights being supplied by the incandescent circuit has been increased recently from 750 to 1000.

HUTCHINSON.—The following are the present officers of the Hutchinson Water, Light & Gas Company: President and manager, W. E. Hutchinson, Boston; vice-president and secretary, George A. Lewis, Boston; treasurer, J. W. Hamer, Philadelphia; chief engineer and eelctrician, James Holt.

KENTUCKY.

LEBANON.—A new electric light and power plant is to be installed here.

FRANKLIN.—Mr. E. E. Kirtley has succeeded Mr. W. H. Isbell as chief engineer and electrician of the Franklin Electric Company's plant.

LOUISVILLE.—When the generating station on the great Ohio Falls, near this city, is completed it will furnish more power than any other single plant. Two hundred thousand horse-power will be generated and distributed to Cincinnati, Evansville, Indianapolis and Louisville.

DANVILLE.—Mr. Frank T. Snyder, representing St. Louis capitalists, has been granted a franchise by the City Council to construct an electric light and power plant. He has also secured a franchise for a street railway and will run an interurban line from Danville to Junction City along the Shelby City pike.

LOUISIANA.

AMITE.—The Amite Light & Power Company recently purchased the electric light plant here and is making extensive improvements and enlargements. High-tension equipment is to be installed as soon as the new building is completed, with the expectation of supplying lighting current to Independence seven miles below here and Tongipohoo, ten miles above, as well as the smaller towns intervening. The system when completed will include ice, light and water plants. C. S. Stewart is president; D. H. Hull, vice-president and manager, and F. T. Mayer, secretary and treasurer.

MARYLAND.

CUMBERLAND.—The water board has appointed Ernest J. Laughlin superintendent of the city electric light plant, to succeed F. P. Lawler, who recently resigned.

BALTIMORE.—Subway Engineer Phelps submitted a report to Mayor Timanus showing the estimated cost of a municipal plant for supplying light, heat and power to the City Hall, the court house, the new docks and piers and Center Market space. He estimates the total cost of the plant at $175,000, and states that it would have sufficient capacity to light the parks as well as the public buildings, the docks and market places.

SALISBURY.—The incorporators of the Wicomico Electric Power Company met in Salisbury and organized with the following officers: Thomas Perry, president; Charles R. Disharoon, vice-president; W. S. Gordy, Jr., secretary; H. L. Brewington, treasurer; W. J. Staton, James T. Truitt, E. A. Toadcine, M. A. Humphreys, J. D. Price, Dr. Samuel L. Graham, of Salisbury. The charter granted at the last session of the Legislature was very liberal, the limit of capitalization being $2,000,000.

HIGHLANDTOWN.—The Baltimore County Water & Electric Company is a consolidation of the Chesapeake Electric & Water Company, Catonsville Water Company and the Towson Water Company. The company lights Highlandtown, Catonville and vicinities, and also supplies light to Relay, St. Denis, Paradise, Irvington, Olla and Orangeville. The company is capitalized at $300,000 and has the following officers: President, Martin Myerdirck, first vice-president, John W. H. Geiger; second vice-president, William S. Speed; treasurer, secretary and manager, Albert H. Wehr; superintendent and chief engineer, S. W. Cooper, and chief electrician, E. G. Rush. The company has under way the installation of a new alternating-current incandescent arc lighting system.

MASSACHUSETTS.

TAUNTON.—The current for the new electric lights which have been installed throughout the J. R. Williams stove lining plant will be supplied from the municipal electric lighting plant.

FRANKLIN.—Mr. George Batchelor has been elected president of the Union Electric Light Company, and Mr. E. L. Blanchard is superintendent. Mr. L. C. Lincoln continues as secretary, treasurer and manager.

LENOX.—A meeting of the Lenox Electric Light Company has been held and the following officers were elected for the ensuing year; President, William D. Curtis; vice-president, Henry Sedgwick; secretary, William G. Clifford; treasurer and water commissioner, Mr. Isaac J. Newton.

CHESTER.—Mr. Leroy Gardner is proprietor of the electric light plant which is operated under the style of the Chester Electric Light Company. The plant has been in operation since 1899 and Mr. Gardner now contemplates increasing its generator and storage capacity in order to meet the additional demand for lights.

BROCKTON.—The Edison Illuminating Company of Brockton has been authorized to issue 1000 shares of additional capital stock at $100 per share. Half of the proceeds will be used to pay off the debt incurred by additions to the plant and the other half will be devoted to the purchase of the plant of the Whitman Light & Power Company.

GREENFIELD.—The Greenfield Electric Light Company has petitioned the Board of Gas and Electric Light Commissioners for an increase of $35,000 capital stock necessary to complete the construction of the large concrete dam and power station on the Deerfield River, the entire cost of which will probably amount to about $125,000. About 1200 horse-power will be developed at the dam, which will probably be sufficient except during a few of the driest weeks in summer, during which period auxiliary power will be obtained from a steam plant.

CLINTON.—In about a year from now the work of building the Wachusett dam will have been completed and there will then be no further use for the power plant now located just across the town line in Boylston. It was suggested at a recent meeting of the Board of Trade that the plant could be made available as a source of power for Clinton industries. The plant is advantageously situated on a spur track already laid from the Central Massachusetts Railroad and it is said that 2000 horse-power could be developed. The plant was installed six years ago to furnish power for the use of the contractors at the quarry and dam, and when their work is completed it is probable that the plant can be purchased very reasonably. The matter will be considered further and its possibilities for utilization thoroughly investigated.

MICHIGAN.

DETROIT.—The Economy Heating & Lighting Company has been incorporated with a capital of $5000.

PENTWATER.—Mr. B. C. Lindley is manager of the plant of the Oceana Electric Company, of this city.

ANN ARBOR.—Mr. A. N. Richardson is superintendent of the plant of the Washtenaw Electric Company.

EATON RAPIDS.—The work of constructing the new electric light plant, for which bonds have been issued, will begin soon.

STURGIS.—Mr. E. B. Gray is purchasing agent and superintendent of the city lighting plant, and Mr. Charles Sprester is chief engineer and electrician.

KALAMAZOO.—The contracts recently awarded for the improvements to be made at the municipal lighting plant include a 400-h.p. engine, 90-light dynamos, boiler, condenser and shafting; also a new switchboard, new piping and 300 enclosed arc lamps. The total cost of the work is estimated at $20,661.

LANSING.—The Platt Power & Manufacturing Company has been organized with a capital of $500,000 to improve the water power in Lansing and extend the heating mains. The company also recently acquired the title to the Dimondale water power. It is proposed to transmit this power to Lansing to be used in connection with the power plants here.

SHELBY.—The council has been considering the advisability of either shutting down the municipal

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electric lighting plant or raising the rates so as to put the plant on a self-supporting basis. It was thought that the outcome of the matter might be the issuing of bonds for the installation of a complete new plant, the present one being inadequate to supply the needs of the village, but this proposition was defeated at an election held for the purpose of deciding the question.

MACKINAC ISLAND.—The Board of Public Works is considering the question of purchasing the water, light and sewerage systems now in operation here. The plant was installed three years ago under the administration of ex-Mayor Bailey at a cost of $108,000, and it was decided at the time that the city should not operate the plant. If the board reports favorably to the council, the matter will be submitted to the people at a special election to be held soon.

MINNESOTA.

MONTEVIDEO.—The electric light plant is installing water-power long-distance transmission lines.

PELICAN RAPIDS.—Mr. C. M. Guy is superintendent and chief electrician of the village lighting plant.

SOUTH STILLWATER.—Mr. Walter Hill has been appointed superintendent of the new electric lighting plant at this place.

FARIBAULT.—The Polar Star Electric Company expects to install very shortly a 150 or 200-kw. generator at its power plant.

STARBUCK.—A new engine is about to be intalled in the municipal lighting plant. Mr. A. H. Dreyer is manager of the plant.

THIEF RIVER FALLS.—The contract for erecting the electric lighting plant here has been awarded to Mr. Carl Bartelson for $2755.

BARNESVILLE.—Mr. L. H. Clark is superintendent and manager of the municipal lighting plant, and Mr. H. H. Pierce is chief electrician.

WINTHROP.—A special election has been held, at which it was voted to issue $7000 bonds for extending the water mains and enlarging the electric light plant.

ST. PAUL.—The St. Paul Gas & Electric Company has been granted a franchise to extend its electric service to Lexington; also to St. Anthony Hill district, this city.

HALLOCK.—Articles of incorporation for the Hallock Light Company have been filed by Edward McVean, P. H. Konzin and others. The company is capitalized at $15,000.

BAGLEY.—Messrs. Kolb & Bohmer, who established an electric light plant here a few months ago, are erecting several blocks of new line and will install some new street lights. They have also secured additional contracts for lighting fifteen residences.

STILLWATER.—The Stillwater Gas & Electric Light Company contemplates making large extensions to its local system. Mr. E. L. Hospes has been re-elected president of the company, and Mr. R. S. Davis has been made secretary and treasurer, succeeding Mr. Otis Staples as secretary and Mr. George Mayer as treasurer.

MISSISSIPPI.

GREENWOOD.—Mr. A. L. Dabney has been elected manager of the water works and electric light plant in this city.

OXFORD.—It has been decided by the Town Council to issue $8000 worth of bonds to establish a new electric light plant.

MACON.—It is reported that all bids have been rejected for the $42,000 bond issue to be used in securing a new water works and electric light plant.

WOODVILLE.—The citizens by an almost unanimous vote have declared for an additional issue of $7500 in bonds for the construction of an electric light plant and water works system.

SENATOBIA.—The municipal lighting plant, which has been in operation since May of this year, is in charge of Mr. F. W. Funk as superintendent.

GREENWOOD.—The city has just purchased the plant of the Citizens' Light & Water Company, of which Mr. C. E. Wright was manager. Bonds to the amount of $15,000 were issued for the purpose.

MERIDIAN.—The new fireproof power house being erected by the Meridian Light & Railway Company is nearly completed. The company is laying several miles of 60 and 70-lb. rails to replace the old 35-lb. rails, and is constantly extending its lighting circuits.

PURVIS.—The Purvis Light & Power Company has been recently organized with the following officers: W. H. Magee, president; J. W. Woodward, vice-president and general manager; C. V. Hathorne, secretary and treasurer. The purpose of the corporation is to operate an electric light plant, a local telephone system and water works and manufacture ice. Orders for the machinery for the electric light plant have been placed.

GREENVILLE.—Mr. E. J. Lentz, superintendent and chief electrician of the Delta Electric Light, Power & Manufacturing Company, writes that extensive and costly improvements are being planned by the company. These will include a $30,000 addition to the main generating plant and the construction of an interurban electric road from this city to Leland, a distance of nine miles. The cost of the road and the necessary additional equipment is estimated at $150,000. The company's lighting circuit comprises 6000 lamps.

SARDIS.—The Panola Electric Light & Power Company has established a light and power station here to furnish light to this city, Batesville and Como. Transmission lines will be built to Batesville, eight miles distant, and to Como, seven miles away. The equipment will include a 100-kw. 60-cycle two-phase alternator, a 138-h.p. automatic engine, four 25-kw. step-up and step-down transformers, two series alternating current arc light systems of 15 lights capacity each, besides other supplies necessary to complete the equipment.

MISSOURI.

WELLSVILLE.—Mr. E. F. McBroom's lighting contract with the city has been renewed for five years.

CANTON.—The new municipal plant for the town of Canton is now in operation. It has cost the town about $16,000. Mr. W. S. Peters is chief engineer and electrician.

ST. JOSEPH.—It is stated that between $6000 and $7000 can be saved to the city in operating expenses of the electric lighting plant if the present antiquated machinery is discarded and modern equipment installed in its place. The citizens have voted for a bond issue of $75,000 to be used in building and equipping a new plant.

TRENTON.—The Trenton Gas Light & Power Company has recently rebuilt its plant and is now operating fifteen motors. The company also has under construction, one mile south of here on Grand River, a new 500-h.p. water power plant, in which turbine wheels will be installed. This plant will cost $50,000 and it is expected to be completed by December 1, 1904.

CARUTHERSVILLE.—The Caruthersville Ice & Light Company is capitalized at $25,000, with the following officers: C. B. Faris, president; H. C. Schult, vice-president; J. F. Franklin, secretary; W. A. Ward, treasurer; J. S. Wahl, manager; B. F. Colter, chief engineer; D. C. Acuff, chief electrician. The company has the city lighting contract, which includes ten 1200-c.p. arc lights at $100 per lamp per year and 100 32-c.p. incandescent lights at $24 each per pear; also six commercial arc lights and 2500 commercial incandescent lights.

MONTANA.

FORT HARRISON.—Bids for installing an electric lighting system have been advertised for, also current for lighting.

MISSOULA.—The Missoula Light & Water Company states that in 1905 a steam plant will be constructed at a probable cost of $25,000.

FORSYTH.—J. E. Edwards has been granted a franchise for the construction of water works and an electric light plant.

BOZEMAN.—It is reported that the Gallatin Water Power Company has been incorporated with a capital stock of $150,000 for the purpose of establishing a power plant at Sheep Rock, on the West Gallatin River. Messrs. George Cox, E. J. Carter and E. W. King are among the directors.

NEBRASKA.

VERDIGRIS.—Mr. M. Gruenberg is manager of the Verdigris Electric Company's plant.

CLARKS.—The electric lighting plant here has been destroyed by fire; the loss is not known.

LINCOLN.—Mr. George H. Morse has been awarded the contract for the construction of the lighting plant for this city, for which $65,000 bonds were issued a few weeks ago.

NEW HAMPSHIRE.

DERRY.—Mr. Harry L. Bartlett has resigned his position with the Derry Electric Light Company to engage in business for himself. He is prepared to do all kinds of wiring and electrical work for parties who may need his services.

NEW JERSEY.

LONG BRANCH.—The Consolidated Gas Company of New Jersey has been consolidated with the Long Branch Gas Light Company and the Long Branch Electric Light Company.

JERSEY CITY.—The incorporation is reported of the Conchas River Power Company, with an authorized capital stock of $25,000. Among the directors are J. E. Kelly and G. E. Griswold.

NEWTON.—The Newton Gas & Electric Company announces that its electric station is being entirely remodelled. A complete three-phase system will be installed, the power to be furnished by gas engines operated from a producer plant.

HAMMONTON.—The Hammonton & Egg Harbor City Gas Company is reported to have purchased from the Atlantic County Electrical Company the electric lighting plant here. The new owners will merge the lighting and gas plants on West End Avenue and expend $16,000 in building a power house and installing new machinery.

HADDONFIELD.—Engineers have reported upon municipal water works and an electric lighting plant for this borough, the plants to be operated jointly and to be constructed at a total approximate cost of $125,000. The proposition, however, has as yet only reached the stage of full discussion, and it may be some months before the construction is authorized.

NEW YORK.

SPENCERPORT.—Various improvements are under way at the electric lighting plant in this place.

ELMIRA.—The Elmira Water, Light & Railroad Company has recently added to its equipment a 1500-h.p. gas engine.

BUFFALO.—The Buffalo General Electric Company has increased its capital stock from $2,400,000 to $5,000,000, and will double the capacity of its plant.

CAMDEN.—A site has been selected for the municipal electric light plant and plans and specifications are being prepared. Bids will soon be advertised for.

ONEIDA.—The Madison County Gas & Electric Company is a consolidation of the Onedia Light & Power Company, Oneida Gas Light Company, J. W. Warner's plant and the Canastota Electric Light & Power Company. The company's authorized capital is $300,000. Mr. C. W. Koiner, of this city, is superintendent and chief engineer.

ALBION.—The Albion Electric Light, Power & Gas Company has elected the following officers and directors for the ensuing year: President, Bird W. Spencer; vice-president and general manager, W. C. Johnson; treasurer, L. H. Tyng; secretary, S. T. Church; who, with Hon. Frank A. Dudley, William Young and Frederick W. Cole, form the board of directors.

AMSTERDAM.—The following are the officers of the Amsterdam Street Railway Company, which owns the Amsterdam Arc Light Company and the Edison Electric Light & Power Company: President and manager, J. L. Hees; vice-president, S. H. Shotwell; secretary and treasurer, G. M. Place;

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purchasing agent, J. N. Shannahan; chief electrician, T. Pettingill.

NEW YORK CITY.—The Miller Electric Company, with offices at 16 William Street, this city, has filed articles of incorporation with a capital stock of $100,000. The incorporators are Alexander A. Miller, August J. Miller and Edward H. Scattergood. The concern will engage in the manufacture and sale of electric light, heat and power for public and private use.

PORTCHESTER.—The New York & Westchester Lighting Company has been incorporated with a capital stock of $250,000 to operate in New York City, Yonkers, New Rochelle, Mt. Vernon and the towns and villages of Westchester County. The directors are named as follows: Cortland Betts, Morristown, N. J.; Fred N. Gilboyl, Brooklyn; Joseph E. Freeman, New York City. The Westchester Lighting Company has been absorbed by the new concern, which is said to be controlled by the Consolidated Gas Company of New York.

LYONS.—At the annual meeting of the Wayne County Electric Company, held recently, the following officers were elected: President, Dwight P. Chamberlain; vice-president, Charles A. Lux; secretary and treasurer, William H. Akenhead. The following-named gentlemen compose the board of directors: John Dunn, Jr., F. C. Eddy, C. D. Beebe, H. H. Crowell, James W. Putnam, Charles A. Lux and Dwight P. Chamberlain. The annual report of the treasurer as presented showed a substantial dividend to have been earned the past year.

NORTH CAROLINA.

ROCKY MOUNT.—The municipal lighting plant is in charge of Mr. A. S. Lyons, as superintendent and manager.

GREENSBORO.—We have been informed that the Cape Fear Power Company will soon move its offices from this city to Fayetteville, N. C.

MAXTON.—The Carolina Electric Company will probably remove its plant to a point about three miles from its present location in order to secure cheaper power.

WILMINGTON.—Mr. R. W. MacRae is chief engineer of the plant of the Wilmington Consolidated Railways, Light & Power Company, and Mr. R. M. Hunt is chief electrician.

BURLINGTON.—Mr. O. P. Dickenson is superintendent and chief electrician of the municipal lighting plant which was installed here a few months ago, Mr. R. E. Andrews being chief engineer.

NORTH DAKOTA.

PARK RIVER.—A new condenser is being installed at the municipal lighting plant, of which Mr. R. G. Wieland is superintendent and chief engineer and electrician.

OHIO.

XENIA.—The Xenia Heat, Light & Power Company is preparing plans for a central heating and electric light plant.

LONDONVILLE.—Mr. John D. Dyerman is manager and superintendent of the municipal electric lighting plant.

HICKSVILLE.—The Hicksville Electric Light Company is considering the installation of another direct-current dynamo.

ANTWERP.—Mr. Henry Harris is the proprietor of the local electric lighting plant. Mr. J. P. Lubbs is chief engineer and electrician.

COLUMBUS.—An ordinance is said to have passed the council providing for an issue of bonds for erecting and completing the electric light works in this city.

ATHENS.—The plant of the Athens Gas Light & Electric Company is reported to have been sold to and succeeded by the Athens Municipal Electric Light Company.

GARRETTSVILLE.—Messrs. A. W. Green, W. B. Martin, O. J. Martin and others have filed articles of incorporation for the Forde Lighting Company, fixing the capital stock at $25,000.

SIDNEY.—The Citizens' Light & Power Company has filed articles of incorporation with a capital stock of $150,000. Mr. G. T. Spahr and Mr. A. Dobbie are named among the directors.

ZANESVILLE.—An ordinance has passed the City Council, granting a franchise to the Southeastern Ohio Railway, Light & Power Company to erect poles and string and maintain lines of wire for conducting electricity to be used for heat, light and power.

OREGON.

GRANT'S PASS.—The Middle Fork Electric Company has been organized here for the development of power on the Middle Fork of the John Day River. Mr. R. C. Reese, of Dixie Meadows, is president of the company.

MOLALLA.—Mr. F. P. Hurst of the Molalla Power & Irrigation Ditch Company has secured the right to appropriate water from the Molalla River for the operation of an electric plant to furnish Canby, Hubbard, Woodburn and other valley towns of Oregon with light.

TOLO.—The Medford & Condon Water & Power Company has its new plant in operation with a present capacity of 800 horse-power, to which 6000 horse-power will be added. The company is furnishing a motor service for mining and irrigation purposes and has secured lighting contracts for Medford, Grant's Pass and Central Point. The lighting and power circuits include forty miles of transmission line. The officers of the company as as follows: President and general manager, C. R. Ray; secretary, E. R. Ray; superintendent and chief engineer, J. D. Alsup; chief electrician, J. K. Soden.

PENNSYLVANIA.

SPRINGFIELD.—The Springfield Electric Light Company, with a capital stock of $5000, has been granted a charter.

DERRY STATION.—Mr. George Mowry is now president of the Derry Electric Light Company; Mr. D. Keit, vice-president; Mr. D. Brown, secretary and manager.

EAST LANDSDOWNE.—It is reported that Philadelphia capitalists are promoting an enterprise for the installation of steam heat and electric light plants in this territory.

SOUTH FORK.—The following-named gentlemen are the officers of the South Fork Electric Light, Heat & Power Company: W. I. Stineman, president; J. C. Stineman, secretary and treasurer; Alex. M. Cover, superintendent; William Rebaugh, chief engineer.

NORTHUMBERLAND.—The Borough Council has adopted a resolution to submit to the taxpayers at the election to be held November 8 the proposition to vote on issuing bonds to the amount of $15,000 for the purpose of building a municipal electric light plant for the borough.

NEW KENSINGTON.—The New Kensington Electric Light, Heat & Power Company is officered as follows: G. B. Ingham, president; Thomas M. Conville, secretary and treasurer; B. J. Rarie, superintendent; John Spencer, chief engineer. The company also furnishes light to Parnassus.

PHILADELPHIA.—Mr. A. J. De Camp is manager of the Philadelphia Electric Company; Mr. H. C. Lucas is purchasing agent; Mr. W. H. Norris, chief engineer of motive power; William C. L. Elgin, chief electrician for the incandescent lighting system, and Mr. A. H. Manwaring, chief electrician of the arc lighting system.

YORK.—The commercial value of the great York Haven electric power plant is now being felt in York as well as in the coal regions. Not only are the local and suburban trolley cars being operated, but a large number of the largest manufacturing plants in the city are being run by means of the river power; it is said that the service is giving entire satisfaction to the manufacturers. The York Haven Corporation has also contracted with the Edison Electric Light Company for the supply of the necessary current for lighting the city of York and private houses.

BEECHCREEK.—The Town Council has passed an ordinance granting to W. P. Mitchell, of Indianapolis, Ind., and N. J. Mitchell, for a corporation to be formed by them, the exclusive right for 99 years to establish a system of water works, electric lighting and sewerage. The water is to be taken from Cove Run, near Mapes, where a reservoir will be built. It is proposed to extend the water works to Blanchard. The electric lighting plan includes the furnishing of light to this borough, Blanchard and Howard. Work on the water system must begin before April 1, 1905, and be completed by Feb. 1, 1906. Two years are given for the completion of the electric light system and 3 years for the system of sewerage. It is stated that the persons interested will at once form a company and apply for a charter.

SHENANDOAH.—The People's Light, Heat & Power Company, of Mahanoy City and Shenandoah, has purchased the ground and the title of the leased land owned by the Hooven Mercantile Company, situated on East Railroad Street, Mahanoy City. Work on the erection of the plant will begin at once as most of the contracts were awarded several weeks ago. At the same time a force of men will be put to work erecting the line between the two towns, taking in the surrounding places. The plant will have an initial capacity of 1000 horse-power supplied by two 500-h.p. direct-connected dynamos, and provisions will be made for doubling this output.

RHODE ISLAND.

NARRAGANSETT PIER.—The Narragansett Pier Electric Light & Power Company states that it is proposed to abandon the present power plant, which, however, will be left intact for the present. Current will be purchased from the Sea View Railroad Company and distributed on its primaries at 2000 volts. The lines are now being placed in condition for this increased voltage. Enclosed arc lamps will be installed and operated on a three-phase system at 60 cycles. Other improvements will also be made.

SOUTH CAROLINA.

BATESBURG.—Mr. Frederick Minshall, of Abbeville, has been awarded the contract for the construction of the electric light plant and system of water works, for which the city recently issued bonds to the amount of $20,000.

COLUMBIA.—The Columbia Water Power Company, which does a power business only, furnishes current to the Columbia Electric Street Railway, Light & Power Company. Mr. Frank P. Carpenter, of Manchester, N. H., is president of the company; Mr. Frederick S. Anabar, Boston, Mass., secretary; Mr. Alvin F. Sortwell, Cambridge, Mass., vice-president and treasurer; Mr. W. M. Shannon, this city, superintendent and chief engineer and electrician.

TENNESSEE.

GREENVILLE.—Mr. H. Reeves, who is proprietor of the local electric light plant, is arranging to install 25 new 6-ampere alternating-current enclosed arc lights with regulators.

KNOXVILLE.—Work has begun on the plant of the Knoxville Power Company, which will be constructed on the head waters of the Little Tennessee by New York capitalists, and in which R. W. Austin, of Knoxville, is interested. The probable cost of the work is $100,000. Mr. John Bogart, of New York, is the chief engineer.

CHATTANOOGA.—Local press reports state that the city of Chattanooga will not build the proposed "suck" power plant. The right as vested in the act of Congress, which was approved by President Roosevelt, April 28, now goes to J. C. Guild, C. E. James and associates, whom, it is reported, will at once take steps to erect the proposed lock and dam power plant to be erected.

TEXAS.

QUANAH.—Mr. E. A. Clousnetzer owns and operates the electric light plant of this city.

CLEBURNE.—L. W. Dunne and associates are reported to be interested in the construction of an electric light plant and street railway at Cleburne.

JACKSBORO.—The electric light plant here is now operated under the style of Hensley Brothers, they having consolidated the Jacksboro Light & Power Company with Hensley & Latimer.

BROWNWOOD.—The Boysen Light & Power Company will probably install within the next few months a 150-kw. alternator and a new Corliss engine. Mr. F. Hall is superintendent of the company's plant.

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LULING.—Mr. F. Zedler is president of the Luling Electric Light & Power Company; Mr. H. Zedler, vice-president; Mr. F. A. Heise, secretary; Mr. Charles Zedler, treasurer; Mr. Oscar H. Stair, manager, superintendent and chief engineer and electrician.

COMMERCE.—The following are the present officers of the Commerce Electric Light Company: President, Mr. T. W. Thompson; vice-president, Mr. W. B. De Jeanett; secretary and treasurer, Mr. J. D. Jernigan; manager and superintendent, Mr. C. E. Randle.

VERMONT.

BELLOWS FALLS.—The following officers have been elected by the Fall Mountain Electric Light & Power Company: President, W. A. Russell; treasurer, P. H. Hadley; manager, L. J. Royce; chief electrician, D. W. Connors.

RANDOLPH.—The White River Electric Company, which holds the city contract for electric lighting, obtains its power from the Bethel Electric Light & Power Company, of Bethel, Vt. Mr. F. H. Ketcham is manager and superintendent.

VIRGINIA.

NEWPORT NEWS.—The Consumers' Light, Heat & Ice Company, of this city, is in the hands of a receiver and the plant is closed, probably permanently.

CULPEPER.—The Culpeper Electric Light Company, composed of Dr. O. Nalle and G. F. Major, is considering the addition of an 8-ton ice plant to its present electric plant.

WASHINGTON.

ABERDEEN.—The Aberdeen Electric Company has sold its property, plant and franchises to the Gray's Harbor Electric Company.

RITZVILLE.—C. O. Green, who owns the Ritzville Electric Light Company, is preparing to install a sub-station at the corner of H and Second Streets.

FOREST.—It is reported that Harry West has secured control of the water power of Hylack Mill for a term of fifteen years and will proceed at once to construct a lighting plant to be operated by means of the power developed at the mill.

MENATCHEE.—Mr. Charles F. Keiser is superintendent of the Menatchee Electric Company's plant. The officers of the company are: President, Mr. Arthur Gunn, who is also manager; secretary, Mr. Charles F. Brown; treasurer, Mr. L. M. Marr.

WEST VIRGINIA.

KEYSTONE.—Mr. G. J. Evans is manager of the plant of the Keystone Light & Power Company, of which Mr. John Evans is superintendent.

MORGANTOWN.—The following are the present officers of the Union Utility Company, which is a consolidation of the Morgantown Electric Light & Traction Company and the Morgantown Electric Light & Power Company: President, I. C. White; vice-president, Davis Elkins; secretary, George C. Sturgess; treasurer and manager, H. R. Warfield; superintendent and chief engineer and electrician, W. S. Ingram.

WISCONSIN.

LAKE GENEVA.—The Equitable Electric Light Company announces that it will extend its lines around Lake Geneva within the coming year.

BALDWIN.—Mr. E. J. Core is owner and manager of the local lighting plant, and Mr. S. F. Core is secretary and chief engineer and electrician.

JANESVILLE.—The Janesville Electric Company furnishes heat, light and power to the city of Janesville, Wis., and operates three generating plants for this purpose. The central or main station is located at Janesville on the bank of Rock River and is equipped with both alternating and direct-current machinery, the direct-current machines being used for the street railway and the larger part of the motor and incandescent lighting loads, while the alternating current generator, in conjunction with the Monterey plant, situated 1½ miles down the river, and the Fulton plant, located 12 miles north of the Yahara River, supply the smaller portion of the incandescent and motor load and the series alternating arc lamps used for street lighting. The machines are driven from a central shaft, which derives its power primarily from water wheels, but steam is also provided as a safeguard against low water or possible injury to the turbines. The central plant is being replaced by a new station, which is located farther up the river, and to which the old machinery will be transferred. The building is to be constructed on the Palmer system, using concrete blocks. The forebay is about 75 feet wide and the center of the measuring gates are approximately 40 feet from the wall of the penstocks. The engine room is 80 feet long by 55 feet wide and has an equipment which should take care of any breakdown that might occur. The direct-current portion consists of six machines. Six turbines are to be used in all; four of them will be 56-inch Samson turbines, while the other two are 72-inch Leffel wheels, which are used at present in the old central station. These turbines are arranged in pairs, two being placed in each penstock, and are so connected to the shaft by jaw clutches that two, four or the entire six may be used at the same time. The company furnishes current for 250 motors with capacities ranging from ¼ to 30-h.p., and the day load is oftentimes heavier than the peak night load. The new plant when completed will be one of the most modern installations of its size in the State.

CANADA.

ST. JOHNS, QUE.—Mr. S. Fletcher is superintendent of the plant of the St. Johns Electric Light Company.

COWANSVILLE, QUE.—The Cowansville electric light plant is now owned and operated by Mr. Nelson Buzzele.

MONTREAL, QUE.—Mr. R. M. Wilson is superintendent of stations for the Montreal Light, Heat & Power Company.

BRANTFORD, ONT.—The Brantford Electric & Operating Company, Ltd., is contemplating installing a new steam plant.

REGINA, MAN.—Mr. J. A. Johnston is manager of the municipal electric light plant of this city, which was established in April of this year.

PERTH, ONT.—The Canadian Electric & Water Power Company announces its intention of installing meters and will abolish the present flat-rate system.

PORT ARTHUR, ONT.—The town authorities are making arrangements to install a new alternator and a 500-h.p. water wheel in the municipal lighting plant. Mr. T. H. McCaubry is manager and superintendent of the plant.

VANCOUVER, B. C.—The British Columbia Electric Railway Company, which furnishes lighting current to this city, New Westminster and Victoria, has acquired the business and plant of the Vancouver Gas Company and announces a reduction of 20 per cent.

PRESTON, ONT.—The taxpayers of the town have decided in favor of municipal ownership of the electric lighting plant. A by-law has been carried to raise the sum of $27,000 to purchase the existing incandescent plant and the arc system now owned by private individuals. A new power house will be erected and a first-class plant will be installed.

CHILLAWACK, B. C.—The Chillawack Power & Light Company, now seeking a municipal franchise, purposes spending $100,000 in developing electric energy for power and lighting purposes. Surveys are being made on the Chillawack River and the general plans for the development of the property which the company has acquired have been determined upon.

SUSSEX, N. B.—The Sussex Water & Electric Company has been absorbed by the Sussex Manufacturing Company, which also controls the William Howes Foundry Machine Shop and the Ross & McPherson Woodworking Company. Mr. S. H. White is president; Mr. G. H. White, vice-president and manager; Mr. H. B. Price, secretary and manager, and Mr. C. D. Mills, chief engineer and electrician.

KINGSTON, ONT.—The city recently took over the plants of the Kingston Light, Heat & Power Company at a cost of $182,000, and they will hereafter be operated as municipal utilities. Mr. John M. Campbell, an electrical expert, has been engaged to investigate the condition of both the gas and electric plants, and the city will make such extensions and alterations as may be necessary to make them thoroughly efficient. It is estimated that about $100,000 will probably be spent in improvements. Manufacturers have been notified of the discontinuance of the flat rate for the present; new rates will be made later on.

WINNIPEG, MAN.—A company has recently been organized here, under the name of the Manitoba Water-Power Electrical Company, with a capital of $5,000,000, for the purpose of establishing a power plant at Silver Falls on the lower Winnipeg River. The officers are: H. J. McDonald, former premier of the province, president; Daniel McMillan, governor of Manitoba, vice-president, and R. L. Roblin, the present premier, secretary and treasurer. The company expects to have the plant in operation in two years and to be able to deliver power to manufacturers at half the present cost of steam. The current will be transmitted a distance of forty miles. About $100,000 has already been spent in development and engineering work.

TORONTO, ONT.—E. J. Davis, Commissioner of Crown Lands, is stated to have turned over to E. W. Backus, of Minneapolis, Minn., president of the Backus-Brooks Company and of the Koochiching Company, the final papers granting full and exclusive water power rights on Koochiching Falls on the Ontario-Minnesota international boundary. The plans of dam construction submitted by Engineers Wallace and Fanning have been approved, subject to the survey of the government engineers. The plans provide for a dam to raise the waters of Rainy River to high-water mark. The dam will produce a fall of about 32 feet, and will develop about 30,000 horse-power, the total cost of the work being estimated at about $500,000. Office of the company is in the Andrus Building, Minneapolis, Minn.

MEXICO.

ARANDAS, JALISCO.—It is reported that the state authorities have granted permission to Porfirio Torres Camerenas, of Guadalajara, to construct and operate an electric lighting plant in this town. The electricity will be generated by means of steam.

TEPIC, TEPIC.—Advices state that a company has been organized by Alfred Lonergan, Cristobal Villanuena and Estiridon Ramirez, all of Ixtlan del Rio, this state, for the purpose of building an electric light plant in this city. The cost of the plant is estimated at $40,000.

AMECA, JALISCO.—Mr. Aurelio Reyes, of Guadalajara, who operates an alcohol factory in this city, has entered into a contract with the City Council for the establishment of an electric light and power plant here. The plant will be operated in connection with the alcohol factory and will cost about $20,000.

TORREON, COAHUILA.—At a recent meeting of the board of directors of the Compania de Tranvias Electricos, of this city, it was decided to endeavor to merge that company and the Torreon Electric Light Company into one concern. It is proposed that the same plant shall furnish power for lighting the city and operating the new electric street railway here.

PUEBLA, PUEBLA.—Miguel M. Navarro, of Mexico City, is said to have obtained a concession from the Government for the construction of a water power plant on River Les Molinos, districts of Atlixco and Cholula, this state. The right to use 3000 liters of water has been secured. The concessionaire has pledged himself to begin work within the next six months.

IXTLAN DEL RIO, TEPIC.—The City Council has entered into a contract with Messrs. Ugarte and Garcia Fuentes, of Guadalajara, for the establishment of an electric light and power plant in this city. The contract calls for 20 arc lights and 800 incandescent lights. It is the intention of the contractors ultimately to secure power from the falls of Elojo de Agua, situated about forty miles from the city.

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

American Electrician.

Vol. XVI. New York, November, 1904. No. 11.

THE ELECTRICAL EQUIPMENT OF A MODERN TYPE FOUNDRY

PLANT OF THE AMERICAN TYPE FOUNDERS' COMPANY AT COMMUNIPAW, N. J.

The American Type Founders' Company has recently established a central plant for the production of printing type at Communipaw, N. J., in which electricity is used exclusively for power and lighting purposes. The main building is a three-story fireproof structure, having a frontage of 200 ft. on Communipaw Avenue, with two 190-ft. wings extending backwards. These wings are connected by two one-story bays which are separated by courts. The buildings were planned with a view to obtaining all the light possible so that they are bountifully supplied with large windows, as some of the illustrations will show. The bays, which contain the type-casting machines, are provided with glass skylights in addition, so that a good distribution of light may be obtained for these important machines. The general lay out is such that extensive additions may be made should future occasion require it.

The power generating plant, which is capable of furnishing all of the power needed in the entire works, both for motors and for electric lighting, is installed at a point on the shop grounds about 200 feet north of the main group of buildings; and from here electric current and steam are delivered to the various buildings through conductors and pipes located in a covered trench. The equipment of the power plant, both mechanical and electrical, is fully in keeping with the character of the building in which it is housed, not only with respect to the thoroughly high grade character of the apparatus, but also to the completeness of detail manifested in the installation. The structure is of brick and is fireproof. It is 150 ft. long by 50 ft. wide, and is divided by brick partition walls into three equal sections consisting of a smelting-room, engine-room and boiler-room, which, owing to the lay of the ground, are arranged step fashion; the boiler-room floor being about 6 ft. below the engine-room floor, and this in turn being slightly lower than the smelting-room floor. This arrangement, while made of necessity, possesses many advantages.

Some of the most noticeable features of the power-house are the abundant supply

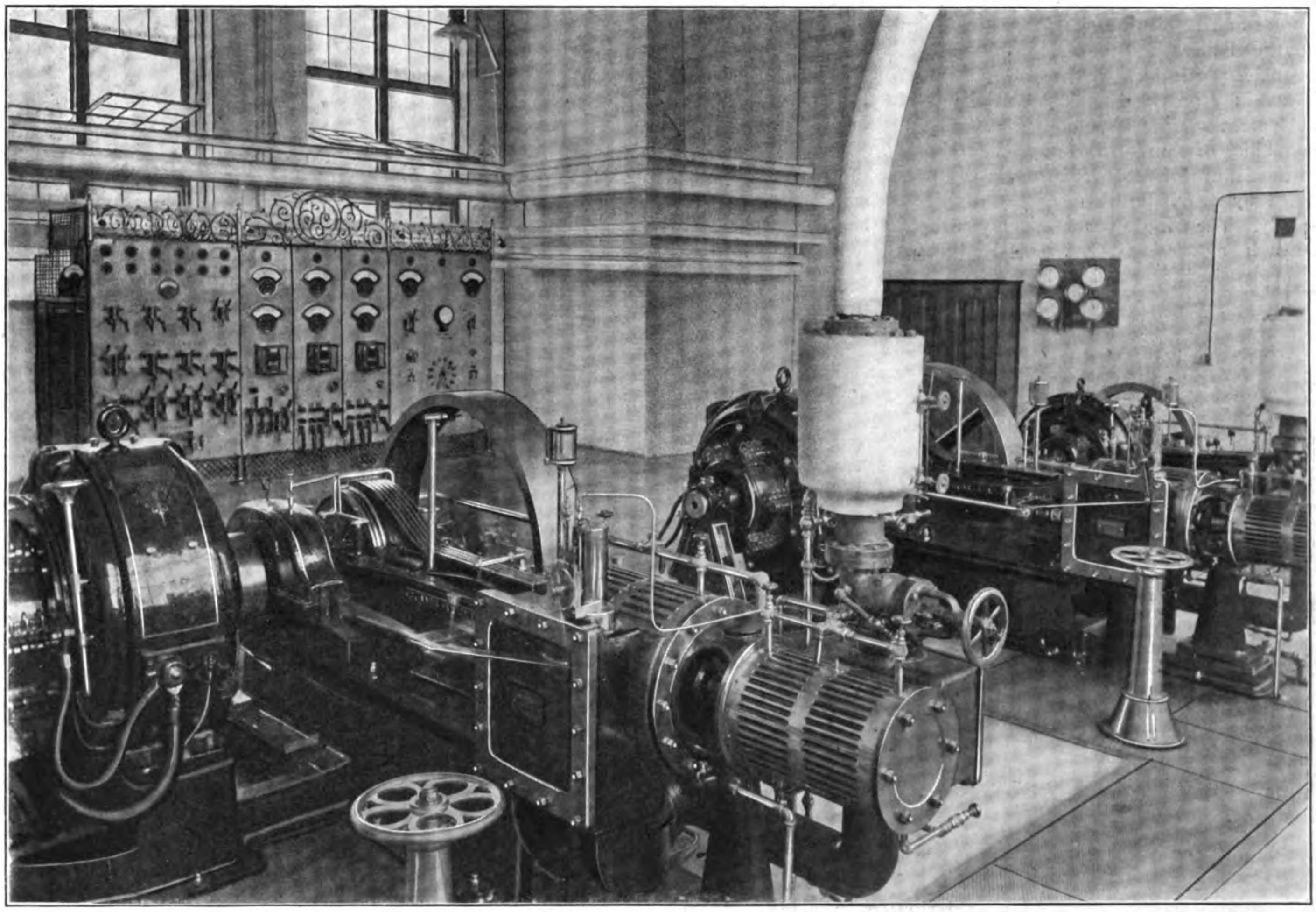

FIG. I.—GENERAL VIEW OF ENGINE ROOM IN POWER HOUSE OF AMERICAN TYPEFOUNDERS' COMPANY.

of daylight and excellent ventilation and the convenient arrangement of all the apparatus. A coal pocket is built outside the power-house with openings into the boiler-room, and the fuel is carted and dumped into the pocket from above. The site is hard by the Jersey Central Railroad tracks, and in time it is hoped that a spur will be built from the road to the coal pocket so that coal will be delivered direct.

The boiler equipment consists of two 150-h.p. Heine water-tube boilers, which are equipped with "Tread-kill" rocking grates made by M. H. Treadwell & Co., of New York, and with improved Argand blowers made by The McClave-Brooks Co., of Scranton, Pa. The usual water columns, feed and blow-off connections, gauges, injectors and safety valves are provided. The smoke breeching delivers into a radial brick chimney 5 ft. in diameter and 100 ft. high, the draught being governed by an automatic Kiely damper regulator placed in the flue. The boilers are hand-fired with buckwheat anthracite coal. Space is provided for the future installation of additional boilers.

Care and taste were shown in the design of the boiler feed and blow-off piping. Troublesome leakage at the blow-off valves is carefully provided against by the use of the patent surface blow-off cocks, and the possibility of shutdown of any boiler owing to the failure of feed-water supply is eliminated by providing two sources of water supply. The feed-water pumps deliver through a 500-h.p. Cochrane feed-water heater built by the Harrison Safety Boiler Works, of Philadelphia, Pa., and thence to the boilers. The connections provided in the feed-water system are very flexibly arranged. There are three pumps provided, one of which may be used as a fire pump. These are all of the Deane duplex type, 7½ and 5 in. by 6 in. They are located conveniently for access in the open space in the boiler-room between the boilers and the engine-room partition. The feed-water heater is located to the left of the pumps. Fig. 3 shows the admirable arrangement of the pumps and connections. The necessary valves are provided for using the pumps interchangeably and for by-passing the feed-water heater should this be necessary. Water is usually taken from the city water mains, but a storage tank of 6000 gallons capacity is provided in addition. A muffler and grease separator is installed in the boiler-room and connected in the exhaust line. Exhaust steam is used for heating, the line being provided with a back pressure valve; but live steam may also be used if required, connections being provided for the purpose through a reducing valve.

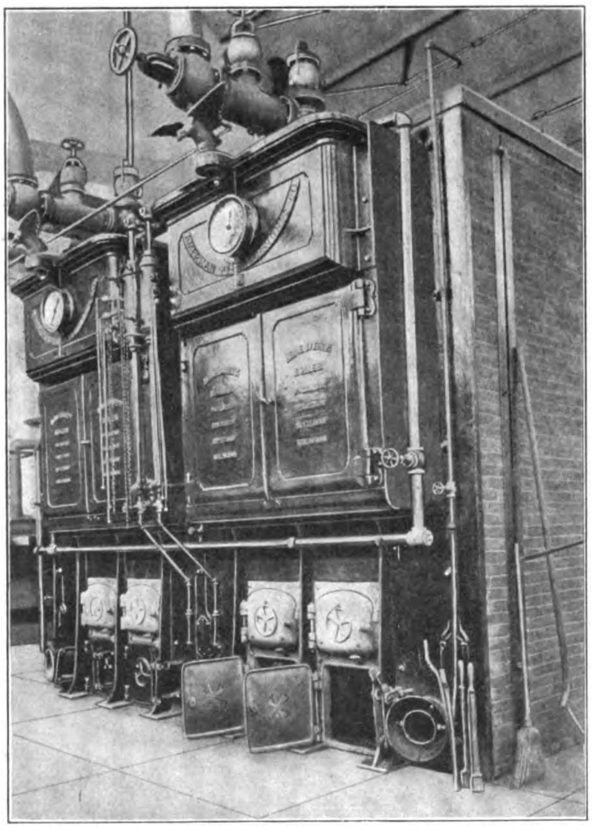

FIG. 2.—VIEW OF BOILERS.

Steam is delivered from the boilers at 135 lbs. pressure through 10-in. copper bends to a single main boiler. Drainage is provided for by a Cochrane separator which bleeds to a Bundy steam trap. To the main header in the boiler room an 8-in. main is connected which runs along the side of the engine-room. This main is controlled by a gate valve. Steam is delivered to the engines through 3½-in. copper bends, each engine being provided with a separator above the steam chest and a gate valve as shown in the leading illustration. The separators are connected to a common return pipe leading to a steam trap, and the low pressure drips on each engine feed to the blow-off tank, check valves being provided on each engine drip.

The exhaust valve of each engine is controlled by a stand and handwheel located on the floor to one side of the cylinder as shown by Fig. 1. The line runs in a covered trench in the floor. Drainage is carefully provided for in the entire system of steam piping as well as at the engines. Condensation is, however, minimized throughout the entire plant by non-conducting coverings on all steam piping which are, in addition, covered with heavy canvas and painted. The auxiliary steam piping for the pumps, etc., is taken direct from the boilers through valves situated directly behind the main valves. The steam piping and boilers were installed by the Blake & Williams Company, of New York City.

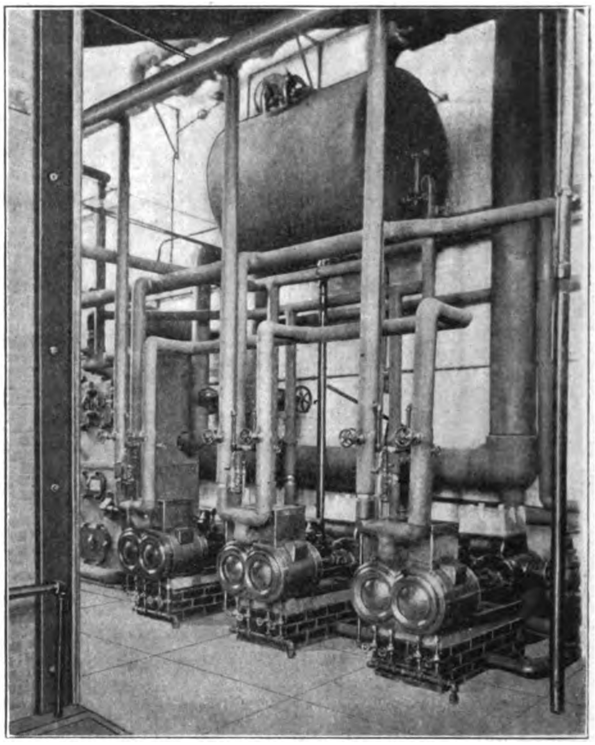

FIG. 3.—FEED-WATER PUMPS AND AUXILIARIES.

The generating equipment consists of three direct-connected units. Two of the engines are tandem-compound of 125 h.p. each, built by the Skinner Engine Company, of Erie, Pa.; the other is a 60-h.p. Woodbury engine, built by the Stearns Manufacturing Company, of Erie, Pa. An automatic oiling system is provided, and the engine cylinders are provided with snifting valves and are drilled and tapped for indicator connections. The engines are operated non-condensing and are provided with the usual centrifugal fly-wheel governor. The generators are all of C & C make, two being of 75 kilowatts capacity, and the other of 30 kilowatts capacity. They are compound-wound machines and generate an e.m.f. of 125 volts. A gauge board is provided on the wall of the engine-room as shown in Fig. 1, containing two high-pressure steam gauges, a low-pressure steam gauge, a recording steam gauge and a clock.

The switchboard is a beautiful five-panel board of 2-in. marble built by the F. A. La Roche Company, of New York, and installed by the Tucker Electrical Construction Company. It is 19 ft. long and stands 8½ feet high, the panels being of a uniform height of 7½ feet and surmounted with an ornamental copper grill. The arrangement of the panels from left to right is as follows: One 5-ft. distributing panel, three 3-ft. generator panels and one 5-ft. storage battery panel. The distribution panel has 12 pilot lamps in a double row across the top, four 50-ampere circuit-breakers, three 400-ampere circuit-breakers, one 150-ampere circuit-breaker, four 800-ampere circuit-breakers, and one 1000-ampere, double-pole switch for connecting the street service should this become necessary. The voltmeter shown in the center of the panel is of the double-reading type, serving also as a ground detector. It is controlled by a push-button switch. The three generator panels are all equipped alike. Each panel has a pilot lamp, Empire voltmeter and ammeter, Thomson integrating wattmeter, field rheostat, plug for parallel connection, one 750-ampere double-pole switch, one 750-ampere single-pole switch and one 750-ampere circuit-breaker. The storage-battery panel has three pilot lamps, Empire voltmeter and double-reading ammeter, one 150-ampere battery circuit-breaker, one 30-ampere circuit-breaker for the booster motor, one Bristol recording voltmeter with a 25-ampere double-throw switch, one 25-ampere circuit-breaker, one 200-ampere double-pole main switch for battery charge and discharge, one 100-ampere motor switch and a ten-point end-cell switch. A swinging differential voltmeter is mounted on a bracket on the left end of the board and is used for coupling the generators in parallel. A rear view of the switchboard is shown by Fig. 5. From this it will be noted that all of the instruments excepting the recording meters are set in the back of the board and have dials illuminated by incandescent lamps from the rear. The connections are neatly and securely made, all of the wiring being enclosed in Circular Loom. The cables from the battery are brought into an iron pole box fastened to the wall, and from there to the switchboard. The cables from the generators are brought across the floor in conduit to the rear of the switchboard, and from the point where they leave the conduit to the lugs on the board they are heavily corded and painted. Upright busses convey the current from the switches to terminals at the top of the board, distribution cables starting here and crossing over to an iron pole box whence they run to the main buildings in a covered trench.

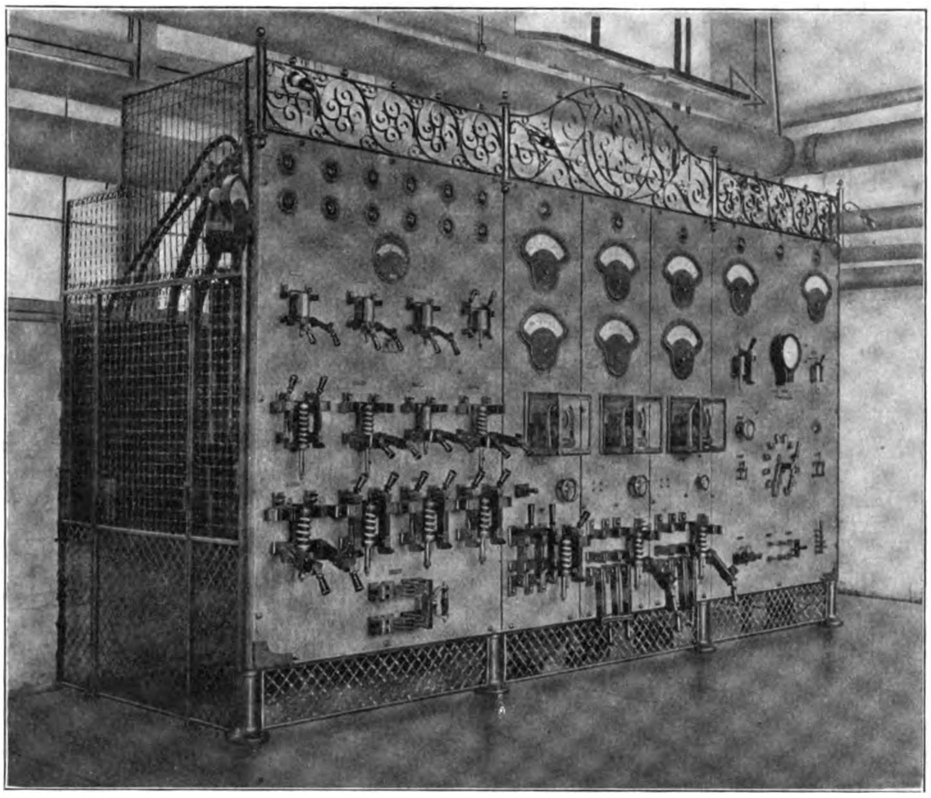

FIG. 4.—FRONT VIEW OF SWITCHBOARD.

In one corner of the room is a small motor-generator made by the Electro Dynamic Company, of Philadelphia, Pa. This is used for charging the battery, the motor operating at 120 volts and 45 amperes and the generator delivering 50 amperes at 60 volts. The battery is of standard make and is composed of 70 Chloride cells, having a capacity of 125 ampere-hours.

The general electrical distribution is on the two-wire system at 125 volts. All of the motors and also the lamps, both arc and incandescent, are supplied with current from the same bus bars in the power plant. The distances from the switchboard to the various points of current consumption are not great so that even with the maximum distance the e.m.f. generated is sufficiently economical, and it was preferable that no higher voltage be used for the sake of simplicity and safety. Only a few arc lamps are used and these are of the enclosed type. The greater part of the illumination is by incandescent lamps. There are in the neighborhood of 1500 drop lights provided, a lamp being invariably placed at each machine tool; whereas for general illumination clusters are used. All of the wiring throughout the buildings is in iron conduit. Leads are run from the various distributing boxes and each circuit feeds about ten lamps.

The main feeders are run from their respective switches on the distribution panel of the switchboard in the power-house through the covered trench to a terminal board in the building. There are six feeders in all, and there are 1,500,000 cir. mil lead-covered cables. In the trench they are suspended on hangers fitted with insulated iron sleeves. Each pair of cables connects to a five-switch panel forming part of the distribution board, and the panels in turn may be connected together with switches so that all six cables can carry the load if desired. The main board has marbleized panels with slate gutters and doors, the copper being highly polished. Fifteen main circuits controlled by as many fused switches furnish the light and power to the main buildings. Each circuit feeds a distribution box which in turn controls the local lighting and power mains. The panel boxes are constructed much in the same manner as the main board, the switches being provided with enclosed fuses and the copper being highly polished. The wiring for the motors is run in iron conduit, the starting boxes for individual motors being placed on the machine within easy reach of the operator as may be seen by reference to Fig. 10.

Fig. 6 is a view of the lower right wing of the machine shop. In this department the machines, being small, are group-driven from line shafting. There are two groups and each is belt-driven by a 5-h.p. G. E. motor mounted on a bracket with the starting box and panel directly beneath.

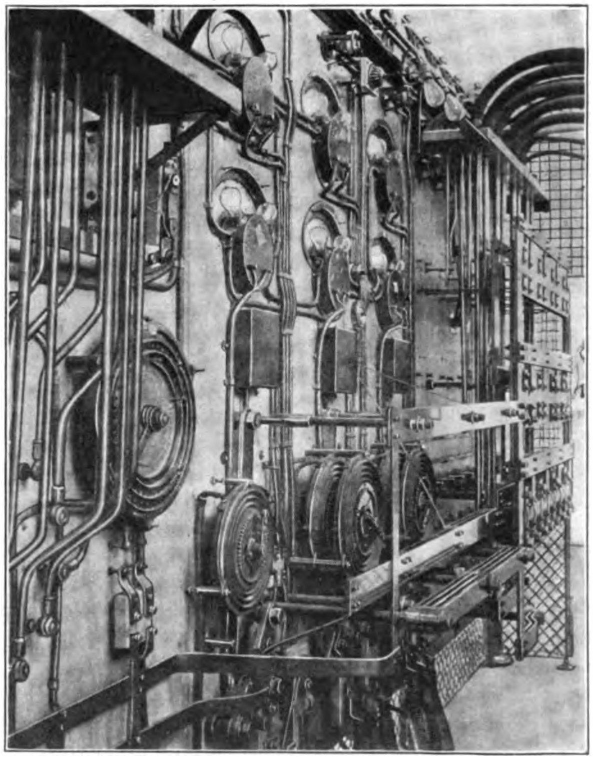

FIG. 5.—REAR VIEW OF SWITCHBOARD.

The bay immediately adjoining this wing

is shown by Fig. 7. Attention may be directed to the care displayed in running the wires and pipes in this bay. In the center of the bay, running the entire length, is a trench connecting with the main trench, and in this are placed electric cables, water pipes, compressed air mains and gas mains; the water, air and gas being used in the numerous type-casting machines in the bay. Four electric circuits are provided in the trench and each of these feeds seven panel switches. These panels have two fused switches each, and from them two circuits lead to floor-boxes from which wires run to the type-casting machines. A switch is provided on each machine with leads running to the starting box of the motor. Connections are also provided for the flexible metallic lamp fixture shown at each machine.

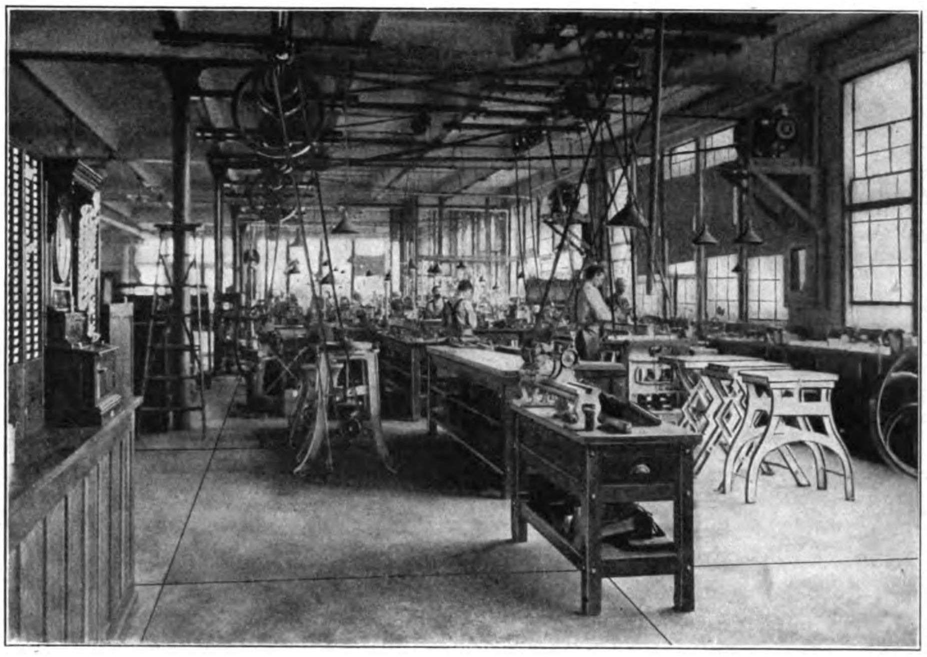

FIG. 6.—GENERAL VIEW OF MACHINE SHOP IN LOWER RIGHT WING.

The operation of type-casting machines has always been difficult owing to the excessive speed variations required. The size of type made by the machines varies all the way from a letter about 1-32 of an inch to an initial letter about 2½ in. wide. The speed of the machine must be regulated according to the size of type being cast, the pumping of metal, cutting, trimming and notching of the type requiring a longer period with large type than with the smaller sizes. The type-casting machines are equipped with Stow multi-speed motors, built by the Stow Manufacturing Company, of Binghamton, N. Y. The motors are back geared and the speed is varied through a wide range by the rheostat and the well-known method used in the Stow motors of changing the magnetic reluctance of the field. Two nicking machines, each driven by a ½-h.p. Holtzer-Cabot motor are also installed.

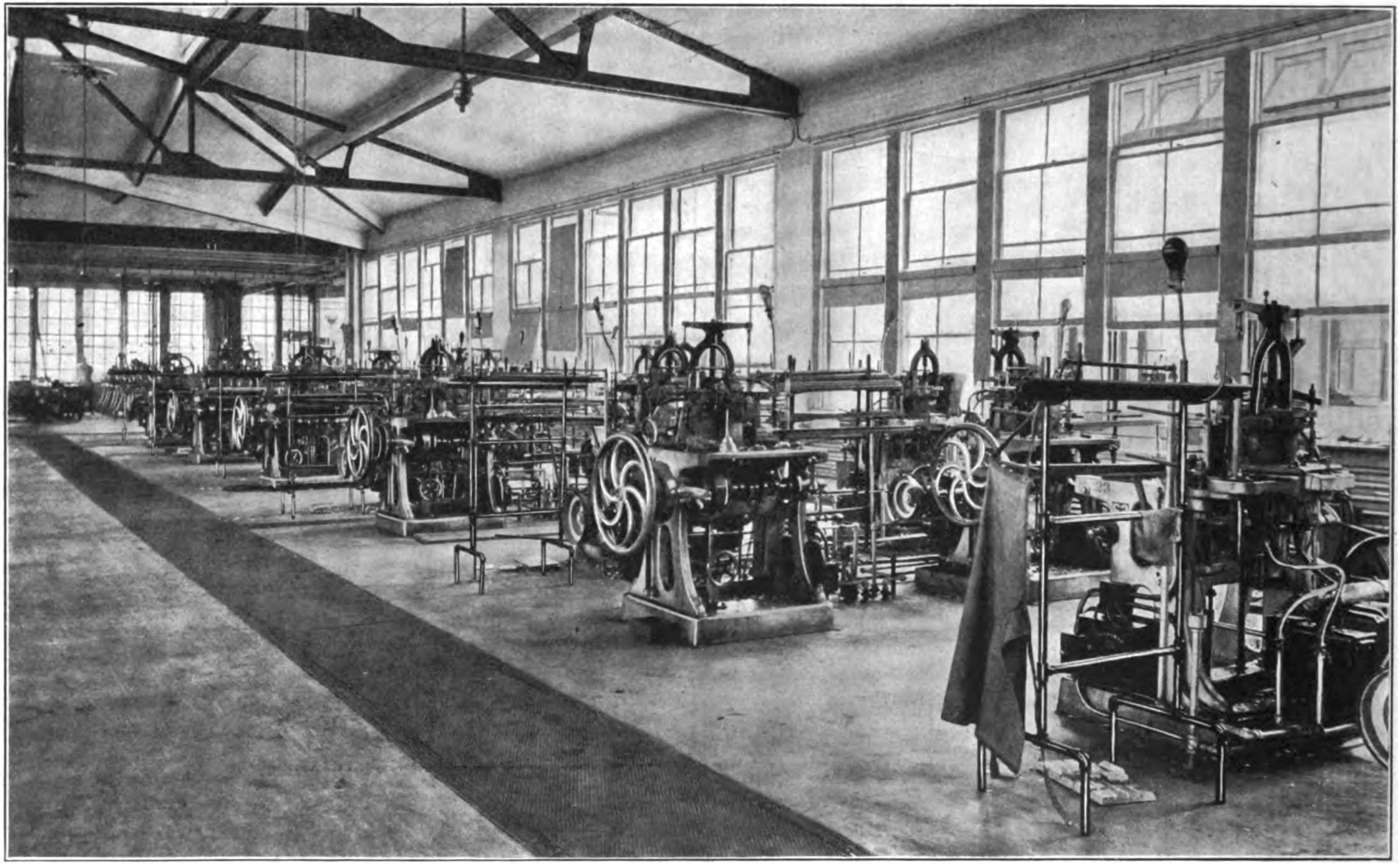

FIG. 7.—VIEW OF BAY CONTAINING TYPE-CASTING MACHINES.

The gas and compressed air are used to generate an intense heat for the crucibles containing the type metal. The compressed air is also used to clear the mould of any metal adhering to it after the type has been cast. A compressed air plant is installed in the right wing to supply this service. The equipment consists of two 8 by 10 Clayton compressors, driven through Renold silent chains by two 7½-h.p. G. E. motors. The compressors store in two large tanks from which the air is fed to the machines under a pressure of 10 pounds. The second bay is also equipped with type-casting machines; but these are of a larger size and require 2-h.p. motors.

The equipment of the engraving department on the second floor consists of eight Holtzer-Cabot motors driving as many engraving machines at 7200 r.p.m. The motors run at about 2500 r.p.m. and are belted to a small countershaft from which a small flexible shaft is driven at the high speed mentioned. The grinders used in sharpening the engraving tools are driven by small Eck motors.

The matrix fitting department contains nine matrix cutters. These are direct-driven by ⅓-h.p. compound-wound Sprague motors fitted with switches on top of the motor. The saws and routing machines in this department are also driven by 1-h.p. and ½-h.p. Sprague motors respectively; the former being direct-connected and the latter belt-driven.

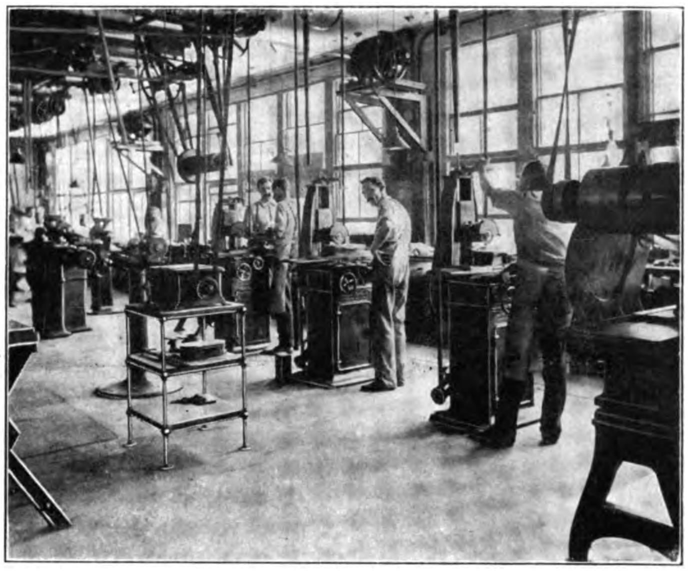

FIG. 8.—VIEW OF MOULD-MAKING DEPARTMENT.

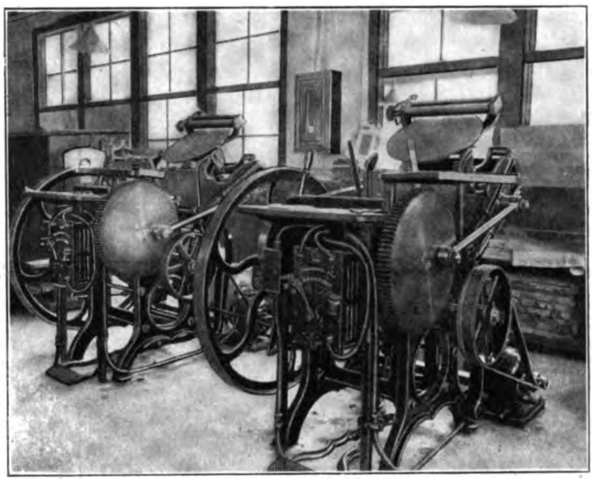

FIG. 10.—MOTOR-DRIVEN GORDON PRESSES.

Fig. 8 is a view of the mould-making department which adjoins the matrix-fitting department. The machines here, like those in the lower right wing, are group-driven by two 5-h.p. G. E. motors. A feature of this department is the magnetic chuck made by The O. S. Walker Co., of Worcester, Mass. One of these chucks is provided on each of the machines shown in the foreground of the illustration. There are four of these machines in operation, one large and three small, and they operate very satisfactorily. A Walker demagnetizer is also provided.

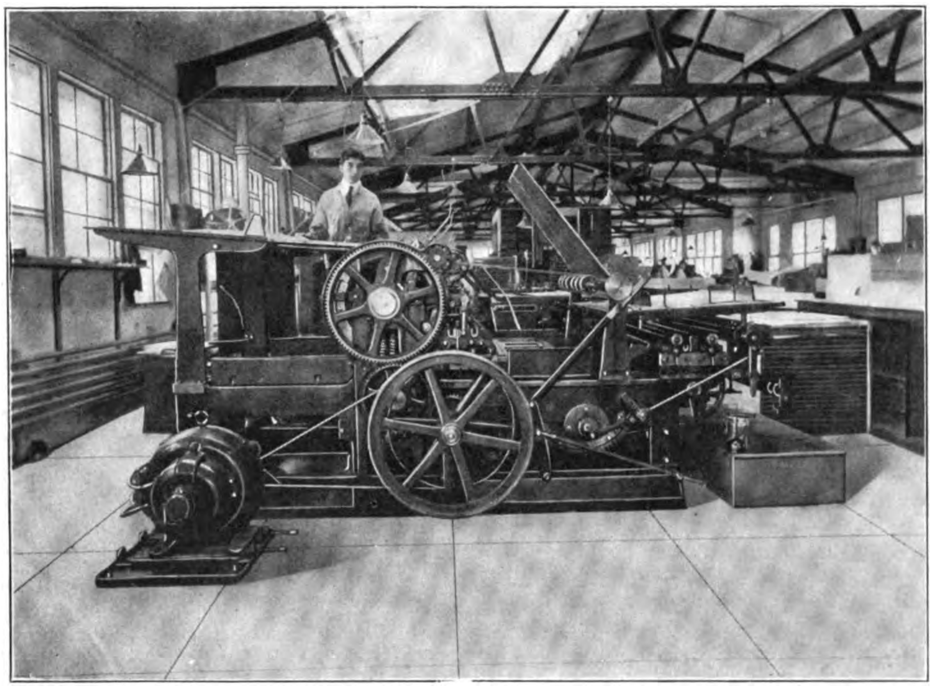

FIG. 9.—MOTOR-DRIVEN WHITLOCK CYLINDER PRESS.

On the third floor of the main building is the printing department. Here are installed five Whitlock cylinder presses belted to 3-h.p. Holtzer-Cabot motors as shown in Fig. 9. Each of these presses is provided with a no-voltage and push-button release starting box made by the Carpenter Enclosed Resistance Company, of New York City. The motor-speed controllers are of Cutler-Hammer make. Other equipment on this floor consists of two Universal presses belted to ½-h.p. Holtzer-Cabot motors; two Gordon jobbers belted to ¼-h.p. Holtzer-Cabot motors as shown in Fig. 10; two cutters belt-driven by 1-h.p. Holtzer-Cabot motors; one folder belted to a ½-h.p. Holtzer-Cabot motor; one stitcher and one saw, each belted to a ⅙-h.p. motor.

The main group of buildings has three electric freight elevators and three automatic dumb waiters. The freight elevators were built by the Marine Engine & Machine Company, of Newark, N. J., and are driven by Crocker-Wheeler motors. Two of the elevators have a lifting capacity of 6000 lbs., and the other has a capacity of 10,000 lbs., the speed of all three being 50 feet per minute. The smelting room, which forms part of the power-house, is equipped with an electric lift for elevating cars from the smelting-room floor to a track running from the smelting-room along the ground to the main factory. The two stirrers in this room are driven by a 5-h.p. G. E. motor through countershafting.

The plant has been in operation now for some time and has given every satisfaction. We take this opportunity to record our indebtedness to Mr. W. S. Marder for courtesies extended in the preparation of this article.

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PENNSYLVANIA STATE INDEPENDENT TELEPHONE ASSOCIATION.

The Pennsylvania State Independent Telephone Association was organized September 27, at Harrisburg, Pa., by representative independent telephone interests. The following is the list of officers: B. F. Meyers, president; R. E. Flinn, vice-president; Charles Griffith, second vice-president; H. E. Bradley, secretary, and C. E. Wilson, treasurer. The executive committee consists of B. F. Meyers, C. E. Wilson, R. E. Umbel, E. D. Schade, C. W. Kline, J. G. Splane, W. D. Barnard, W. B. Trask and G. B. Rudy.

At the afternoon session held the next day, the following papers were submitted and read: "Long-Distance Service Equipment," by S. H. Browne; "Telephone Auditing," by I. D. Gindhart, Jr.; "Progress of Independent Telephony," by W. Scarlett; "Telephone Exchange Equipment," by C. Russell, and "Traffic Associations," by H. E. Bradley. In the evening a banquet was held at which many prominent independent telephone men made addresses.

FEED-WATER HEATING.

BY R. T. STROHM.

Three considerations demand that the feed-water, before being permitted to enter the boiler, shall be heated to a greater or less extent. Some plants may involve all three, and others only two. But for at least two good reasons the boiler feed-water should be passed through a preliminary heater. The first consideration is that of economy. Manifestly, it will require less heat to change a pound of hot water into steam at a given pressure than to convert a pound of cold water into steam of equal pressure. Consequently, each heat unit added to the water before it reaches the boiler is a gain, as far as the fuel consumption of the boiler is concerned. The saving which can be effected, therefore, is directly proportional to the rise in the temperature of the feed-water. The percentage of saving in fuel which may be secured by heating the feed-water is easily calculated, knowing the steam pressure and the initial and final temperatures of the water, by the use of the formula

$$k = \frac{100\,(t'' - t')}{H - t + 32}$$

in which

k = percentage of saving;

t'' = temperature to which the feed-water is heated;

t' = temperature to which the feed-water had formerly been heated;

H = total heat of the steam at the usual working pressure;

t = initial temperature of the feed-water.

For example, suppose that in a plant using water whose initial temperature is 60° F. and generating steam at 120 pounds gauge pressure the feed-water temperature should be increased from 140° F. to 210° F. The fuel saving would then be

$$k = \frac{100\,(210 - 140)}{1188 - 60 + 32} = \frac{7000}{1160} = 6\% \text{ nearly.}$$

This, it must be understood, it but the apparent saving, however. The actual net saving will be less, owing to the fact that it becomes necessary to deduct from the above an amount equal to the sum of the interest on the heater investment, the cost of repairs, and the depreciation loss.

The second consideration is that of safety. It is no longer a matter of doubt as to what effect cold feed-water has upon a boiler, especially one carrying high steam pressure. Engineers have come to recognize the fact that it is extremely poor practice to introduce comparatively cold feed-water into a boiler whose plates are at a temperature of from 100° to 200° higher than that of the water. The contraction and expansion set up, due to changes of temperature, hasten the deterioration of the shell and weaken it, by the well-known principle of fatigue of metals, and are contrary to all ideas of safety.

The third and last consideration is that of purification. It is this one which may exist only in occasional instances. The two foregoing reasons apply to every plant. But since feed-waters contain many impurities which no amount of heating will remove, purification by this means is possible only in certain instances. For example, if a feed-water contains carbonate of lime or of magnesia, heating it will serve to drive off the carbonic acid by which the carbonates are held in solution, thereby precipitating them. The sulphates may also be thrown down by heating to a temperature of nearly 300° F. If the feed-water contains acids, mud, grease or organic matter of various kinds, simply heating it will not purify it.

Boiler feed-water is heated by either or both of two methods. First, it may obtain its heat from steam, or it may absorb heat from the furnace gases after they have left the boiler heating surfaces. If steam is used for heating, it may be either live steam, taken direct from the boiler, or it may be exhaust steam from the engines, pumps and auxiliary apparatus, which might otherwise go to waste.

At first glance, it would seem impossible to gain anything by taking steam from a boiler to heat the feed-water for that boiler, except in the matter of purification and the prevention of stresses due to unequal expansion. The idea of a thermal gain, or saving of fuel, would seem preposterous, inasmuch as all the heat taken from the boiler would be returned thereto, neglecting radiation losses, leaving the heat balance just the same. Yet the actual economy of this method has been proved by the use of live steam heaters, and hence there must be some rational explanation of the apparent contradiction. The explanation lies in the fact that the hot feed-water is better able to absorb heat rapidly than the colder water, while at the same time the circulation is augmented, which further tends to increase the rapidity of heat transmission. The prevention of heavy scale formations also facilitates the heating and reduces heat losses.

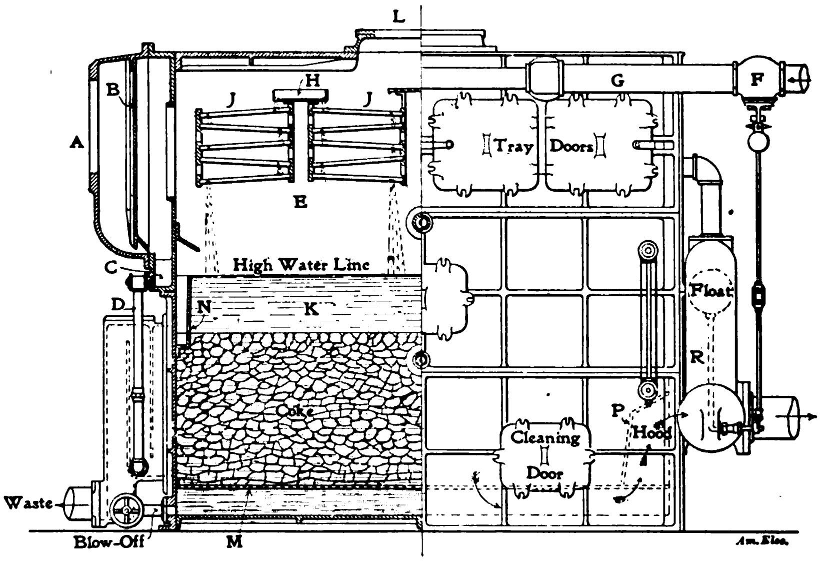

FIG. 1.

As commonly understood, a feed-water heater is a device which enables the heat of exhaust steam to be returned to the boiler, and by far the larger number of heaters are built for this purpose. If the heater is built to utilize the heat of waste furnace gases, it is termed an economizer. A live steam feed-water heater is usually spoken of as a purifier, because that is its main purpose, and so there is little or no likelihood of confusing these types of heaters.

Exhaust heaters, or more simply, feed-water heaters, are divided into two general classes, known as open heaters and closed heaters. In the former the feed-water is exposed to atmospheric pressure, being in contact with the outside air. In the latter there is no contact of feed-water and atmosphere, the water being enclosed in the heater and subjected to the pressure existing in the boiler, for which reason this class is frequently designated by the term "pressure heaters." There is no mingling of steam and feed-water in the closed heater. Each has its own path of circulation, heat from the steam being transmitted to the water through metal walls separating them.

Open heaters may be still further subdivided into two groups, known as direct-contact heaters and coil heaters. In the direct-contact open heater the exhaust steam is led into a chamber where it is mingled with a spray of water, heating the latter and condensing the former. This chamber is open to the atmosphere, which permits all uncondensed steam to escape. In the coil open heater a number of coils of pipe are arranged in an open tank or vessel, the exhaust steam passing through the coils and heating the feed-water which surrounds them.

A well-known type of direct-contact open heater is illustrated by Fig. 1, one half being shown in section and the other half in outside elevation. The heater proper is an approximately rectangular box built up of cast-iron plates securely bolted together, these plates being ribbed on the exterior surfaces to give the requisite strength. The exhaust steam enters at A, where it is immediately thrown against a vertical ribbed plate B which deflects the current and at the same time catches the particles of oil which come over from the engine cylinder. The oil and condensed steam then drip from the plate *B* into the pocket *C* and thence to the waste overflow through the drip pipe *D*. The steam being thus purified to a large extent, passes on into the condensing chamber *E*, where it meets the cold water supply. The water enters through the regulating valve *F* and the pipe *G*, the latter having two branches, one opening into each half of the heater. One branch, shown only in part, conducts a portion of the feed supply to the pan *H*, whence the water overflows and runs down upon the inclined trays *J*, *J*, which have serrated edges, and are alternately inclined at opposite angles, so as not only to break up the feed-water current into a number of thin sheets, but at the same time to give it a comparatively lengthy travel before allowing it to drop into the hot well *K*. A similar set of trays occupies the upper part of the other half of the heater, and they are supplied with water by the other branch of the pipe *G*. The steam, coming in contact with the thin sheets of water as they fall from tray to tray, rapidly heats the water, adding to the latter the condensation resulting. Any steam not condensed escapes by the outlet *L* to the atmosphere. The water thus heated falls to the bottom of the heater, which forms the hot well. In the lower part of this chamber is a perforated plate *M* which supports a thick bed of coke through which the hot feed-water must pass on its way to the boiler. The coke forms a filter bed which not only removes any impurities entrained by the incoming feed, but also catches the carbonates of lime and magnesia which have been precipitated by the heat of the exhaust steam. A skimming device *N* serves to remove all of the lighter impurities, such as oil and scum, which would float on the surface of the water, and discharges them into the waste pipe.

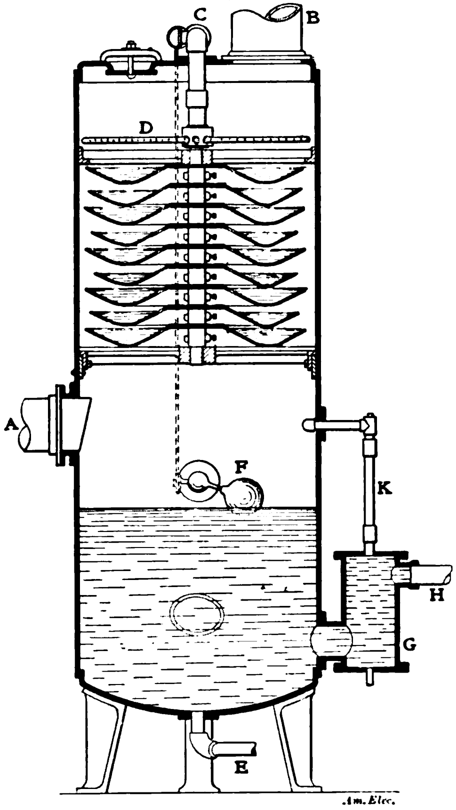

FIG. 2.

The purified feed-water, having reached the chamber beneath the perforated bottom, passes under the hood *P* into the pump suction chamber *R*, in which is a float regulating the supply valve according to the demands made upon the heater by the boiler feed pump. The hood *P* prevents the passage of any of the hot feed-water to the pump without first going through the filter bed. The heater is provided with a large number of cleaning doors by which entrance to the interior may be had, to remove the trays or to clean the inner surfaces.

Another type of direct-contact open heater is illustrated by Fig. 2. It has a cylindrical iron shell supported on legs, into which the exhaust steam is admitted at *A*, and from which all uncondensed vapor escapes at *B*. The cold feed-water enters through the balanced valve *C*, and passes thence to the distributer *D*, falling into the upper tray of the series contained in the top of the heater. The top pan or tray becoming filled, the water runs over its inner edge, falling to the tray below, filling the second and then flowing over its outer rim to the third, and so on. The incoming water is thus divided into a large number of thin sheets which rapidly absorb heat from the exhaust steam. The lower half of the shell forms a settling chamber, and is furnished with a blow-off valve *E* by means of which the precipitated impurities may be blown out at intervals. A float *F* regulates the rate of inflow of the cold water, the hot feed-water leaving the heater through the small cylinder *G*. The arrangement of this auxiliary cylinder is such that no oil can be pumped from the heater to the boiler. For, if the water level falls below the level of the suction pipe *H*, the pump will draw steam through the pipe *K*, breaking its action and preventing its taking any more water until the level rises.

The open heater of the coil class consists merely of a tank full of water in which is submerged a coil of pipe through which the steam is circulated. It is not a much-used form because of its low efficiency, but it is easy to construct when there is no possibility of obtaining a better, which is probably the only reason for its use.

A closed heater is shown in section by Fig. 3. In this type the water occupies the main part of the shell while the steam circulates through the pipes. The exhaust steam enters the heater at *A* and passes downward through the left bank of tubes until it reaches the closed chamber *B*. Here the direction of the current is changed and the steam ascends through the right bank of tubes to the outlet *C*. All condensation which results from the giving up of heat is collected in the chamber *B*, together with the oil carried over from the engine. These are removed by means of a trap connected to a drip pipe *D*. The feed-water enters at the lower connection *E*, flowing upward and across the heater to the outlet *F*, thus necessarily passing among the heater tubes. It will be noticed that the direction of flow of the water is directly opposed to that of the steam, which is the condition required for obtaining maximum feed-water temperature.

The tubes in this heater are given a bend at their lower ends, being expanded into a cast-iron plate at the top and into the roof-shaped cover of the chamber *B* at the bottom, this chamber forming the oil separator. The separator is thus suspended from the upper tube sheet by means of the heater tubes. The reason for this peculiar construction is to allow perfect freedom for contraction and expansion. One of the great problems in the design of tubular feed-water heaters is to obtain a form which will maintain tight joints and yet permit the expansion and contraction which inevitably follow changes of temperature. By the construction shown in Fig. 3 there is little or no restriction offered to either change of length or position of the tubes, so that no strains are set up which could loosen the joints and cause them to leak.

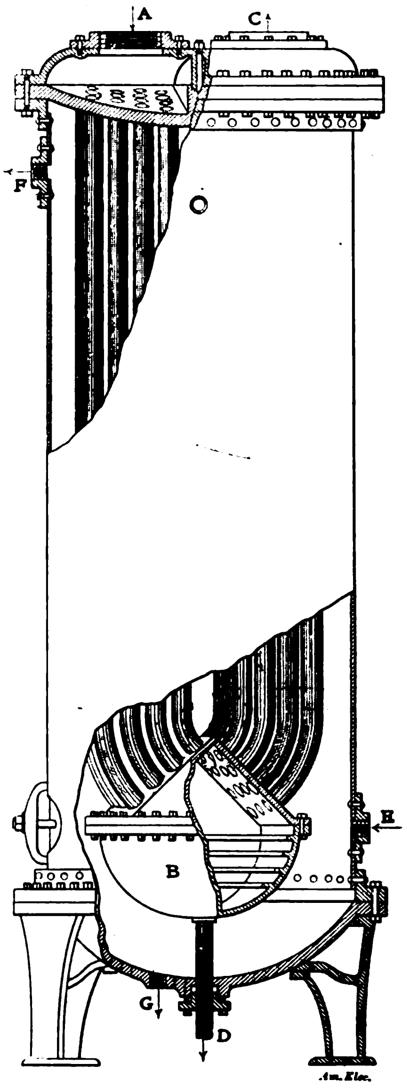

FIG. 3.

To prevent the steam current from picking up the oil from the bottom of chamber *B*, as it reverses in direction, the lower walls have a number of projecting baffles cast on them, which, by their downward slope, tend to check any upward movement of water or oil. Beneath the oil separator, and forming the lower end of the heater shell, is a hemispherical settling chamber in which the precipitated impurities collect and are removed by the blow-off pipe *G*. The drip pipe *D* is provided with a stuffing-box and gland, allowing vertical motion without leakage.

Another form of closed heater is illustrated by Fig. 4. It differs from the previous one in that the steam flows outside the tubes while the water flows through them. The shell is of cast-iron with a large chamber at each end. The water enters the lower one, *A*, in a direction almost tangent to the interior surface of the shell, instead of diametrically. The result is that the feed-water is given a whirling motion in the chamber *A*, making it practically certain that the water will rise through all the tubes in approximately equal amounts, a thing which might not happen if the water in the lower chamber were quiescent or nearly so. The tubes are corrugated, as shown, and are made of copper, being rigidly fixed into the upper and lower cast-iron heads of the heater. The corrugations offer sufficient flexibility to take up all expansion or contraction which may occur. At the same time they increase the effective heating surface and cause the water to be kept thoroughly agitated while flowing through them. The feed passes upward and out at *B*, while the exhaust steam entering at *C* passes downward and out at *D*. The usual drip and blow-off pipes are provided, at *E* and *F* respectively, while a relief valve is placed at *G*. Every heater through which water is forced on its way to the boiler should have a safety or relief valve on it to prevent damage in case the pump is started while the boiler feed valve is closed.

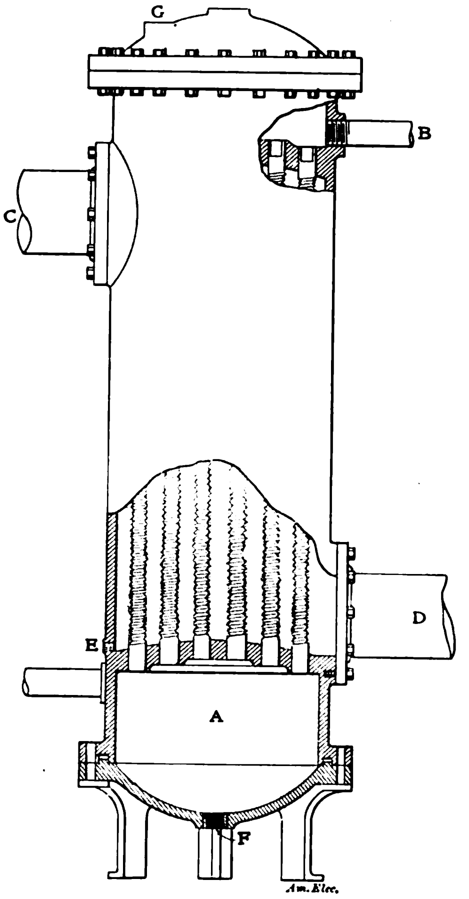

FIG. 4.

Still another method of making allowance for the expansion and contraction is to arrange the heater tubes in long coils made of seamless copper pipe, and fastened rigidly at their ends only, somewhat as in Fig. 5, the feed-water going in at *A* and out at *B*. The steam rises vertically through the heater from the inlet *C* to the outlet *D*. Iron rods, *E, E, E,* sustain the weight of the coils but do not hinder their lateral movement.

The reason for using copper pipe in many of these heaters is to obtain rapid transmission of the heat, inasmuch as the thermal conductivity of copper is much greater than that of iron, which means that one square foot of copper pipe will transmit more heat in a given time than a square foot of iron pipe, all other conditions being the same.

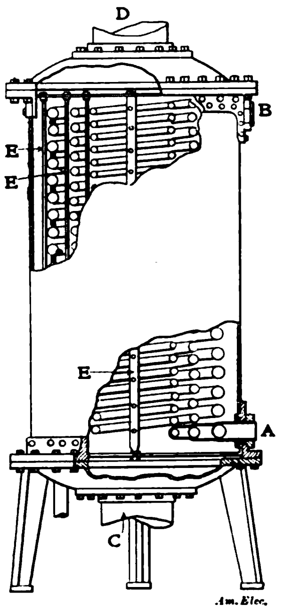

FIG. 5.

The economizer, which is a special form of feed-water heater, is radically different from the ordinary exhaust heater in its construction and operation, and hence will not be described in this connection. Indeed, the subject of economizers is quite extensive enough to warrant its treatment in a separate article.

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DISTRIBUTING SYSTEMS FROM THE STANDPOINT OF THEORY AND PRACTICE.

BY PHILIP TORCHIO.

Systems of distribution of electrical energy are classified into *direct systems*, which utilize directly, without transformation, the electricity furnished by the generating station; and *indirect systems*, which modify the intensity and potential of the current by means of secondary apparatus, such as transformers, storage batteries, etc.

The direct systems are adopted where the electrical energy generated is to be distributed in the immediate vicinity of the power station. Since the beginning of the early eighties it was, however, a recognized fact that on account of the prohibitive cost of transmission to great distances the direct systems alone could not give the solution of the general problem of economical generation of large amounts of power at a central point and economical distribution to distributing centers covering large areas, more or less distant from the station.

One of the first solutions which was suggested was the use of direct-current, high-tension transmission, feeding in series a number of electric storage batteries distributed at convenient points along the high-tension circuit. Each storage battery would independently, supply current to the local installation lamps. The limitations of this system were soon recognized, and its importance was lost when the alternating-current transformer was brought into the field.

The National Company for Distribution of Electricity by Secondary Generators, Limited, exploiting the inventions of Messrs. Gaulard and Gibbs, showed in 1884, at the Exhibition of Turin (Italy), a system consisting of a 30-h.p., 2000-volt, 50-cycle, single-phase alternator, feeding a single wire transmission circuit 48 miles long, having connected in series at different points along its route a number of transformers of the Gaulard and Gibbs type, feeding at different voltages through their secondaries a variety of incandescent and arc lamps.

Gaulard and Gibbs, recognizing as important that an alternating-current transmitting system should be capable of transforming alternating into direct current, devised a high-efficiency, direct-current, autocommutating machine, which was schematically a self-starting, single-phase, 50-cycle, rotary converter. Soon after the close of the Turin Exhibition of 1884, Messrs. Zipernowsky, Deri and Blathy developed the parallel type of transformer for connection in multiple arc, which was exhibited at the Budapest Exhibition of 1885.

The results obtained with the Gaulard and Gibbs transformers at the Turin Exhibition attracted the widest attention among engineers, and opened the way to classical laboratory researches and monumental discoveries in the field of application, which laid the foundation to all future developments. From this beginning it became apparent to the best engineers what was the line to follow in the development of the distribution of electrical energy.

Since 1884 great progress has been made in the applications of electricity, but it is remarkable that in no essential features have the systems as developed departed from the general lines conceived at that time.

There have been and there still are differences of opinion as to more or less important details, but the general idea set forth, of a single generating station transmitting high-tension current to centers of distribution, which is then transformed to lower potentials for supplying the translating devices, has been the keynote of all the later developments. The problem of distribution is at present narrowed down to the consideration of engineering and commercial features, which must now guide the engineer.

One of the main points to solve is, how to distribute the low-potential current to the translating devices? One is thus brought to face the selection of a system which will give the most satisfactory result, and to select between overhead lines or underground distribution, direct-current system or alternating current, and whether single-phase or polyphase system, and of two, three, four or five-wire distribution, the selection of the suitable voltage for translating devices and a number of other similar questions.

Now by defining any of these features one affects the whole system and gives a characteristic stamp to practically every piece of apparatus required for the generation, distribution and utilization of electric current. It is evident, therefore, that on account of the complexity of the problem the systems of distribution could not be studied from the standpoint of theory alone. One can, with the aid of mathematics and physics, analyze special features of any one system, but to make the applications one must always bring to bear all the commercial and practical considerations which are also factors of the problems and which cannot be expressed by formulas.

To study intelligently any one problem one must have before him the most salient conditions to be met. Among these characteristic conditions are the following:

(1) The amount and character of business; (2) the local field of development; (3) the density of distribution; (4) the local conditions of cost of real estate for sub-stations; (5) the fire hazards; (6) patents and questions of policy; (7) the cost of capital, and (8) the cost of station supplies.

General considerations of the above character are usually sufficient to determine the main features of the system to be selected; or at least they will shape the problem within well-defined limits, which will point to only a few alternative solutions which can then be treated on their respective merits.

It would be impracticable to attempt to co-ordinate the knowledge we have of the different systems in order to arrive at general conclusions which could then be applied to any individual case. There are, however, general features that any system must possess, and among them the most important are the following:

(*a*) An ideal system should be of the greatest simplicity; (*b*) a distributing system should be as uniform and flexible as it can be made; (*c*) a system must be as economical as possible to install and to operate, at the same time fulfilling the requirements it has to meet; (*d*) a system must be reliable.

We may now see how the different systems commonly used in practice comply with these general requirements. For convenience we may subdivide the systems into *overhead* and *underground.*

Outside of local installations for factories or other plants for special local purposes, we may broadly state that overhead systems are applicable where the territory covered is scattered or the demand for current is light. Underground systems instead are only applicable to territories densely built up with heavy demand for current.

In the case of overhead distribution for lighting in scattered districts, single-phase distribution is usually preferable; two or three-phase generators can be used at the station, and the additional power wires required for any motor installation above 10 or 15 horse-power can easily be strung on the existing pole lines without heavy extra cost. The problem does not present great difficulties, and the engineer is governed by common practice.

In the case of underground distribution in heavily loaded districts, one usually finds an existing system already fully developed, and the extension of that system is usually a foregone conclusion.

There is no definite line of demarcation between these two cases, and it would be difficult to say when it would pay to put an overhead line underground. There is, however, no doubt that when a system has reached a density of about 1000 kilowatt demand per square mile, the extra cost of an underground system is no longer prohibitive, and the standard of the service would be materially enhanced. There are now in America a number of such overhead systems, which have grown to large proportions and which will gradually be put underground in the near future.

It is in these cases particularly that the engineer will be called upon to select a system which will meet the new conditions, and it is precisely in these instances that one is liable to find great differences of opinion among engineers. As this is an important subject of live interest, I shall take a practical case upon which to fix the ideas in the general discussion of the problem of distribution.

Let us assume a concrete case of a medium-sized city, covering a territory of, say, 10 square miles, and having at present the following classes of service:

Series city lighting, 750-kw. max., series direct current.
Multiple incandescent and arc lighting, 1500-kw. max., alt. cur., single-phase.
Power service, 750-kw. max., 500-volt direct current.
Total, 3000-kw. max.

Of the total amount of station output, the business section of the city, covering, say, one-half a square mile, would take about the following percentages:

City lighting	10%—	75 kw.
Incandescent	75%—	1125 kw.
Power	80%—	600 kw.
Total		1800 kw.

The existing customer installation in this district would consist, say, of 150 series arcs, 40,000 equivalent 16-c.p. incandescent lamps, 100 multiple arcs and 1800 horse-power of motors. It is proposed to put this section of business underground. We shall assume that the location of the generating station is fixed by existing conditions, and that the alternating-current generators are wound two-phase, 60 cycles. For a first case we shall assume that the station is 5000 ft. distant from the center of the underground section. Let us then consider the systems that could be applied to the underground territory with the view of selecting a system that shall be *simple, flexible, economical* and *reliable.*

For the sake of simplicity of generation and distribution, we should adopt, if possible, a system having a common source of supply for all services, and a common set of distributing mains similar to the distribution of water and gas. For the sake of flexibility, the network of mains should be a meshed system, making a solid network of cable mains all of one or two standard sizes, so that extensions can be made without replacing any of the cable previously laid. To be economical the system should require low fixed charges for interest and depreciation, have a high efficiency at maximum load and good all-day efficiency. To be reliable any part of the distribution should be free from interruption of current on account of troubles at the generating end or at the transmitting and transforming apparatus. In this country it is customary to insure against any conceivable kind of losses and to consider too lightly the obvious safeguards against the failure of the light and power supply that moves the wheels of trade of the business section of an important commercial center would be an unpardonable mistake of serious commercial detriment to the supply company. On the other hand, an almost absolute guarantee of reliability of service would be invaluable to the successful exploitation of the product. The remarkable success achieved by almost all Edison companies, with their splendid records of continuous uninterrupted service, gives an inkling of the great importance of some of the purely practical considerations not taken account of by theory.

Besides these general qualifications the system should have all those points of superiority that would make the service best adapted to the utilization of the current by present and prospective customers.

It is not probable that all of these requirements could be fully met by any one specific system. We shall have, therefore, to undertake several tentative solutions and then discuss the different results each on its own merits.

The first solution that suggests itself is the continuance of the existing system readjusted for underground conditions. The 500-volt power service and the series city lighting could be readily adjusted for underground operation. The standard American type of subway construction with its great flexibility would not present any difficulties in carrying out this work. For the incandescent lighting we would have to build a system of ducts for drawing in a number of single-phase circuits, feeding one or several transformers at the centers of small districts, each covered by an independent small network of three-wire, low-tension mains (Fig. 1). The transformers would have to be installed either in manholes under the street surface or in kiosks in the street or in the cellars of private customers. Any one of these locations is more or less objectionable. The manhole location requires perfect sewerage conditions, and also requires for reliability of operation that each transformer be fed by a separate feeder, thereby eliminating the primary fuses which are unreliable in a manhole, and also in some cases making possible the use of transformers of low iron and high copper loss, and regulated by individual regulators for each feeder. Transformer-houses or kiosks on business streets are seldom practicable, but would be fairly satisfactory in operation. When insurance regulations allow it and convenient leases for long periods can be arranged, the private building location is preferable. Transformers in this case should be installed in suitable enclosures, these enclosures being accessible by a locked door preferably opening on the street, or in any event always accessible at any hour of the day or night. The dependence upon a number of private owners is, however, somewhat of a drawback in most instances where this system is in use in this country.

Let us assume to have settled upon a definite location as found best suitable for the conditions. In the case of manhole transformers for commercial and technical reasons, it will be advantageous not to make the transformers and districts too small and for safety not too large. We can then decide upon say 12 100-k.w. transformers, supplying 12 independent districts. For emergency conditions we shall provide suitable switches for tying together neighboring districts, thereby making it feasible for the trouble man to give temporary relief to a district which, through the failure of its primary feeder or transformer, has been put out of service.

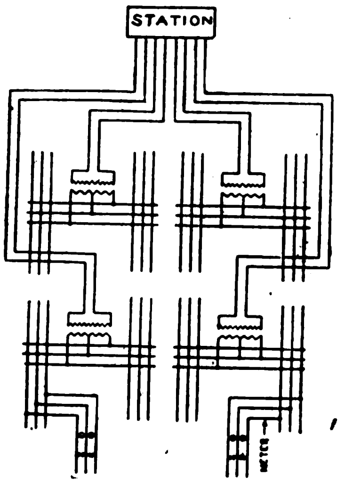

FIG. 1.

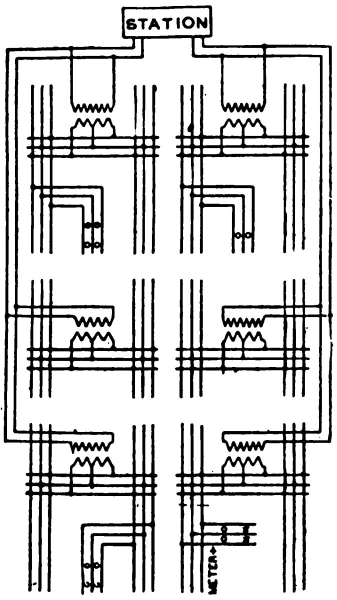

FIG. 2.

In the case of transformers in kiosks or private buildings, we may safely use secondary fuses with the transformers and connect several of them so as to feed into a large meshed network of mains. We may, for instance, divide the whole underground section into two districts designed to subdivide the load approximately equally between the two phases of the generators, and in each district have six primary feeders, with 100-kw. transformers, as before, the only difference being that the secondaries of each six transformers would be connected in a meshed network of mains, each transformer being protected by secondary fuses or by circuit breakers in case of large transformers.

By using different criteria in design and adopting good regulating transformers, we may arrange the primary feeders for the two districts last mentioned in a different manner. We may use two single large feeders, connecting all six transformers in multiple for each district (Fig. 2). This arrangement requires primary fuses for each transformer and independent secondaries for each transformer district. To mesh into a network also the secondary mains of the six districts, thereby forming a meshed primary and meshed secondary, distribution would be unsafe owing to the difficulty of properly subdividing the loads among the different transformers; this is, however, done in some cases and with proper protective devices and careful study of the layout the system might be made operative. It is understood that with this system the regulation of all six transformers being done at the station upon a single feeder, this must be designed for a small maximum drop not to exceed, say, 2 per cent, otherwise poor regulation will result. The all-day efficiency of the system is, however, lower than in the case of the individual feeders for each transformer; it is, therefore, better adapted to plants where energy is cheap, as in water-power plants.

The solution of our problem along the above lines would not give us the desired unification of the generating station; the subdivision of the underground system into small districts would not give us the advantages of a meshed network, thereby reducing to some extent its flexibility and largely the reliability of service of any one district. In fact this continuity is dependent exclusively upon the year in and year out absolute freedom from failures and breakdowns of any part of the long cable feeder and transformer supplying the network of mains in the district.

As to economy, one can see without making calculations that the three independent systems of generation and distribution of current for the three separate classes of service cannot lead to maximum economy of investment and cost of operation and maintenance.

The unification of generating apparatus can readily be decided upon from the consideration of respective percentages of power required for different services. As 50 per cent of the total output is for alternating 60-cycle lighting, 25 per cent for direct-current series arc lighting and 25 per cent for 500-volt power, and as the alternating current 60-cycle service for the overhead distribution is a necessity, the selection of alternating-current 60-cycle generation is a foregone conclusion. The series direct-current service could, in the majority of cases, be economically transformed into a series alternating-current system with constant current transformers; or, if preferable, the direct-current arc machines could be operated by alternating-current motors, the selection depending upon consideration of local requirements. Whatever developments in the art of arc lighting may follow the investigations and experiments that are now being made, they will not be in the way of the direct or indirect use of alternating current. The 500-volt power generation could be obtained from motor-generator sets, the motors being operated from the 60-cycle alternating-current supply. It is, however, doubtful if the existing 500-volt generating units are reasonably efficient, that it would pay to discard them and add the investment of new motor-generator sets. In many cases we may, therefore, have to abandon the idea of unification of generating apparatus and possibly only add some synchronous motor-generator sets that would tie together the two systems and serve as reserve, and also for shutting down the system at light loads.

We would, therefore, have a composite station with 75 per cent in alternating-current generating capacity and 25 per cent 500-volt, direct-current generating capacity. Any further step toward unification of the system will depend entirely upon what can be accomplished in the unification of the distributing system in the underground district representing the bulk of the commercial light-and-power service. We may neglect the question of the city series arc in this district, as most probably the series alternating-current system would do for the case or multiple arcs fed from the lighting mains could easily be adopted, if found convenient. The serious question to face is the supply of current to motors. If single-phase, alternating-current motors could be made to operate under the same conditions that direct-current motors are operated, there is no question that even at the large sacrifice of replacing with new alternating-current motors the 1800 horse-power of customers' motors, it would pay in the end to do it, as we would save the duplication of separate mains for light and for power and we would be in the position of securing the advantages of unification of station apparatus and more economical operation. At present single-phase alternating-current motors cannot meet these requirements, and as the several attempts to develop a commercially satisfactory single-phase motor have been only partially successful, we may exclude it from consideration. The promises held forth in the field of single-phase railway motors may eventually bring the long-wanted solution, but at present, while there are undoubtedly many cases where single-phase motors could and should be used, we still shall have to operate the 500-volt power circuit for a number of cases where the present single-phase motors are not applicable. Therefore, we are brought to the conclusion in favor of a composite alternating-current and 500-volt, direct-current generating station and duplicate system of distributing feeders and mains for light and for power. This conclusion seems hardly logical, but there are open only two other alternatives, which are hereafter discussed.

The first alternative is the adoption of polyphase-current distribution for the underground districts as used for the overhead district. The second is the distribution of direct current through an underground

Edison three-wire system. Before comparing these two systems, we must make a statement of fact that as far as the electric service requirements in the business section of a city are concerned, the direct-current systems have no drawbacks to contend with in the unlimited variety of their applications, while the alternating-current systems, without any advantages in efficiency, are, in many cases, handicapped by limitations in their adaptabilities to meet important uses, as, for instance, in the case of variable speed motors for elevators and hoists and the direct charging of storage batteries. The greater adaptability of direct-current motors in city work is, in the case of low-speed motors, usually accompanied by lower first cost and higher efficiency of operation. Another consideration is the presence in a business section of quite a number of private plants, all operating direct-current generators and translating devices. Central station break-down connections for these prospective customers become impossible with alternating-current systems of distribution, and their limitations in adaptability to specific services and the difficulties encountered in readapting the existing installations of motors and arc lamps make the eventual full central station service to these customers very difficult to secure, without making local installations of direct-current converting apparatus to be operated continuously. A few large installations of this kind would weigh a good deal in the final results. Returning now to the study of the application of polyphase and direct-current systems, we shall take up first the polyphase system.

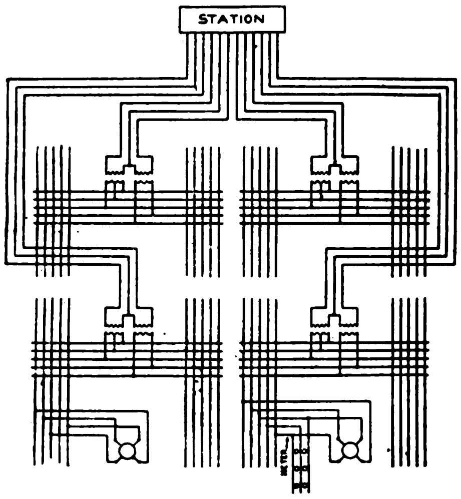

FIG. 3.

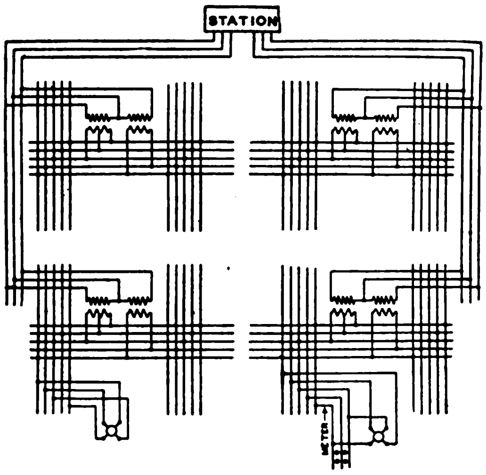

FIG. 4.

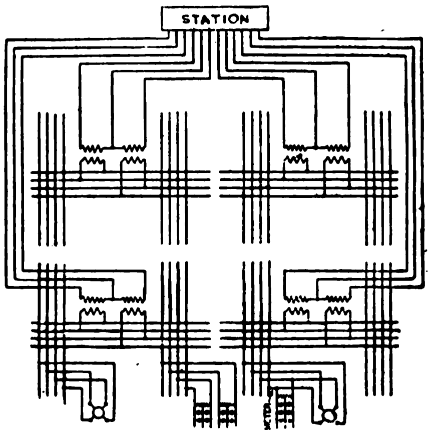

FIG. 5.

Having at the generating station two-phase generators, we shall lay out an underground two-phase system. By rewinding the generators it may be feasible to use three-phase distribution if we shall find it preferable. The two-phase distribution could be accomplished according to several plans. One plan would be to adopt the single-phase distribution for light by districts, as in the previous case, and parallel the system with primary feeders, transformers and a two-wire network of 220-volt mains of opposite phase for power (Fig. 3). The primary feeders could be two duplex cables or one three-conductor cable, using the third wire for the power circuit, regulators being mounted only on the lighting circuit. This system would not be less complicated than the previous system with 500-volt direct-current mains, its only advantage being the unification of generating apparatus at the station.

A two-phase three-wire meshed primary and a three-wire meshed network of 110-volt mains could supply light and power to the whole district (Fig. 4). It is an unbalanced system even at equal distribution of loads among phases; it requires a large amount of copper for mains, on account of the low voltage; the metering of current at customers' premises requires polyphase meters or two single-phase meters for each class of service; the neutral of the three-wire wiring in buildings must be of larger cross-section than the outside wires, which is not always the case in existing installations. On account of all these drawbacks, this system may be discarded for our case. By using a five-wire meshed network of 220-volt mains, the total amount of copper for mains could be reduced, but it would add complications of wiring without corresponding advantages.

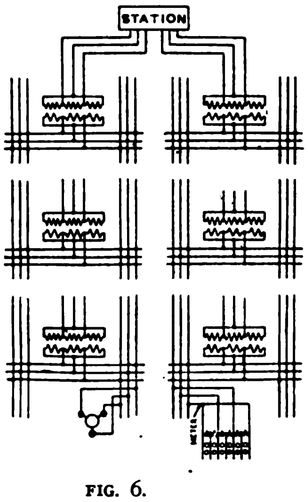

FIG. 6.

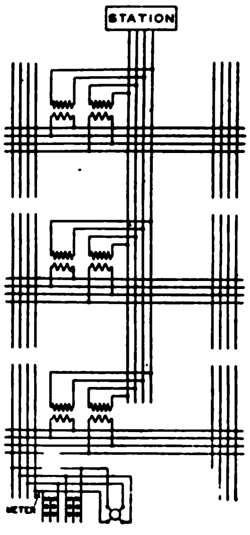

FIG. 7.

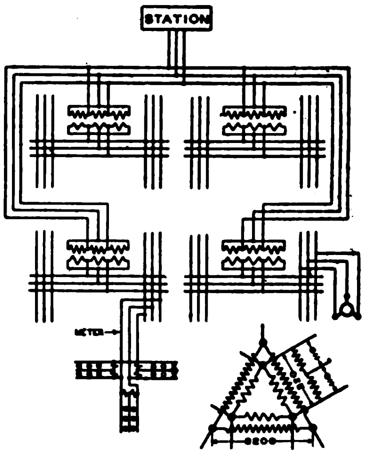

FIG. 8.

A duplicate three-wire single-phase system along the lines first described would have the advantage of good regulation with reasonable requirement of copper, but the six cable wires would be cumbersome and costly. By omitting the neutral wire and delivering 220-volt current for each phase the last system could be reduced to four wires, which would be an advantage if 220-volt incandescent lamps were as efficient and 220-volt arc lamps as satisfactory as 110-volt lamps. In 1901* the writer demonstrated that for conditions similar to the one under consideration, it would not be economical to use 220-volt lamps. The tendency upward due to the advantages of high voltages in the case of the Nernst lamps is now offset by the tendency to lower voltages in the osmium lamps. We have, therefore, to discard the system as unsuitable for our conditions. We could, however, install at each customer's premises a balancing 2 x 110-volt transformer, which would permit us to use the two-wire 220-volt mains and the more efficient 110-volt lamps (Fig. 5). In most of the cases this arrangement would work well, but in a dense district such as we have under consideration, the first cost of these balancing transformers, together with their losses, would undoubtedly make the system as expensive as the neutral main wires which they replace. This system is, however, the best that can be made out from a two-phase distribution, and we shall, therefore, give to it further consideration in our final selection.

If we adopt three-phase generators we

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can select between a three-wire or a four-wire system for the primary feeders and several combinations of secondary mains. The straight three-wire primary would, perhaps, be preferable; we would then use three-phase or two-phase T-connected transformers and make the combinations desired on the secondaries. We can then distribute through a three-wire network of 110-volt mains, but its cost would be high. We can distribute through a six-wire network of 2 x 110-volt mains, but the six-cable mains would be cumbersome and expensive. We can distribute through a three-wire network of 220-volt mains, but it would not be economical on account of the low efficiency of 220-volt lamps. By the use of the balancing transformers (Fig. 6), we would obtain the best workable three-phase three-wire system, which we shall consider later.

By dividing the underground territory into three equal districts and operating three-phase generators, one can lay out some system by which light is delivered single-phase by a three-wire network of mains for each district, and power from an additional two-wire cable main. This system, which works very well for overhead conditions, would be expensive and undesirable for underground conditions.

From this review of the alternating-current systems with distributed transformers, we have found that the following systems are more or less desirable, but all of them possible for our conditions:

Case A.—Single-phase distribution of light, 500 volts for power separate (Fig. 1).

(1) Twelve independent two-wire primary feeders, equally divided between the two phases, each one feeding a separate secondary district, consisting of a single-phase transformer supplying a three-wire, 2 x 110-volt network of mains.

(2) Same as (1), but with each group of the same phase of secondary district mains connected in two solid mesh networks.

(3) Same as (1), but with only two single-phase, two-wire primary circuits, one for each phase, mesh primaries (Fig. 2).

Case B.—Two-phase distribution for light and power.

(4) Twelve independent three-wire primary feeders, each one feeding a separate secondary district consisting of a set of two-phase transformers, supplying a three-wire, 2 x 110-volt network of mains, and a two-wire, 220-volt network, the latter being used for motors only (Fig. 3).

(5) Same as (4), but with two halves of the district mains connected in two solid secondary mesh networks.

(6) Same as (4), but with only two sets of two-phase primary circuits, meshed primaries (Fig. 4).

(7) Twelve, or less, two-phase primary circuits and sets of two-phase transformers with twelve, or less, districts, covered by duplicate two-wire, 220-volt; single-phase network of mains, with balancing transformers at customers' premises for lighting, the lighting of each customer being from one of the single-phase circuits, the balancing of phases being accomplished by distributing evenly the customers' connections between the two phases (Fig. 5).

(8) Same as (7), but with the mains of all districts connected in a solid meshed secondary network.

(9) Same as (7), but with only one set of two-phase primary circuits, meshed primaries (Fig. 7).

Case C.—Three-phase distribution for light and power.

(10) Twelve, or less, three-wire, three-phase primary feeders, each one feeding a separate secondary district consisting of a three-phase transformer supplying a three-wire, 220-volt, three-phase network of mains with balancing transformers at customers' premises for lighting, the installations of any importance being wired for three independent three-wire circuits, one for each phase (Fig. 6).

(11) Same as (10), but with the mains of all districts connected in a solid meshed secondary network.

(12) Same as (10), but with only one set of three-phase circuits, meshed primaries (Fig. 8).

As an alternative to any of the above systems with distributed transformers, we may select equivalent secondary networks of mains, fed by low-tension feeders from a single sub-station, at which are located all the step-down transformers. As we have already noted the practical drawbacks of distributed transformers in a heavily-loaded district, it is important to give the case of a sub-station thorough consideration. The objections to the distribution of large amounts of alternating current, through lead-covered cables, are in practice less serious than one would expect. Care must be taken in the sub-station and subways to eliminate looping of phases with iron pipes or other magnetic materials, but the difficulties would not be greater than in all other wiring for alternating-current distribution.

For our underground district, we could apply four layouts corresponding to (2), (5), (8) and (11), which we shall designate respectively by the numbers 13, 14, 15 and 16.

(13) With a single-phase for lighting and 500-volt, direct current for power, the alternating-current distribution from sub-station could be accomplished by dividing the system into two equal and independent sections, for balancing the phases of the two-phase generators, and feed the two sections, each covered by a meshed network of mains, by means of low-tension feeders in the same manner that Edison three-wire systems are operated. For feeders and mains the Edison tubes would fill the requirements exceedingly well, though for practical reasons cables would be preferable. In cases of cables the feeders should be of multi-conductor type, making them the equivalent of an Edison three-wire tube; the mains should preferably be single-conductor cables. The regulation of each feeder could probably be efficiently obtained by having the secondaries of the step-down transformers built with a neutral tap at the middle and a 10 per cent or 15 per cent tap on each end, each tap being connected to corresponding station busses, the middle bus being for the neutral of the feeders and the two sets of outside busses being intended for connecting of an auto-transformer regulator mounted on each outside leg of the low-tension feeder. The two regulators would give perfect regulation for drop in feeders as well as for unbalancing of the two sides of the three-wire system. The single-phase, two-wire, 220-volt distribution with balancing transformers at customers' premises would save the neutral wire of feeders and mains; a balancing transformer at the end of each feeder would save the neutral feeder wire. In the case of a two-wire, 220-volt distribution with balancing transformers, it may be desirable to distribute the two-phase current, single-phase, from a single set of busses into a single meshed network of mains. This could be done by using the transformers of special design and of somewhat larger capacity, connected in two-phase relation on the primaries and the two secondaries in series delivering single-phase current (Fig. 10). The secondary winding must be specially designed for avoiding magnetic unbalancing on account of the regulating taps on one end of each transformer.

(14) With two parallel sets of low-tension feeders and mains, one single-phase, three-wire for lighting and power, and one alternating-current, two-wire, 220-volt for power only, the system would require similar layouts, as just described, for the single-phase system (13), with the addition of two-wire circuit feeders and mains for which, however, no regulation would be required at the sub-station, thereby making the sub-station connections rather simple and, perhaps, also, poor regulation in the line permissible. With this system it would be necessary to operate the underground districts divided into two equal sections operated from two busses (Fig. 11). With balancing transformers at the end of lighting feeders or at customers' premises, the neutral wire in feeders, or feeders and mains, could be saved, thereby making the distributing system four-wire instead of five-wire.

(15) By connecting lights on both circuits of the four-wire system last mentioned, we would have independent wires, two-phase distribution with two wires, 220 volts on each phase and balancing transformers at the customers' services. The balancing of phases would be accomplished from house to house. The secondaries would form a solid meshed network of four-wire mains. Both mains in each street require regulation at the sub-station and same regulation in lines (Fig. 12).

(16) Three-phase, low-tension distribution can be done by three-wire, 220-volt feeders and mains and balancing transformers at customers' premises, balancing of phases being accomplished by subdividing important lighting customers' wiring in three equal and independent parts, one for each phase (Fig. 13). Independent regulation of each phase is practically impossible with this system; each phase being dependent upon a fixed relation to the other two, making it necessary to act at the same

time and in different degrees upon all the phases. This regulation can be accomplished better on the high-tension side of the three-phase transformer by individual regulators on each of the three legs. In practice with generators of good regulation and a large network of three-phase, low-tension feeders and mains mesh connected in conjunction with the compensating effect of all three-phase motors, it is probable that independent regulation of phases could be done away with. It would be necessary for the regulation of each feeder to provide a step-down transformer with its primary regulator for each feeder, which, however, is not a drawback, as in our case transformers of 200 or 300 kw. capacity could be used. This would give the greatest independence, but it requires the continuous operation of all step-down transformers, unless some combination of switches is arranged on the feeders at the sub-station, by means of which a combination of two or three feeders can be operated from a single transformer and the underload transformer cut out of service. Accordingly, for the last conditions, which are preferable for good service, the transformers should be designed for highest full load efficiency, while in the case of continuous operation they should be designed for the lowest iron losses.

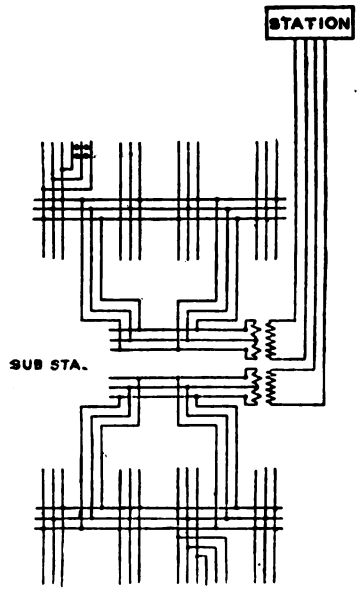

FIG. 9.

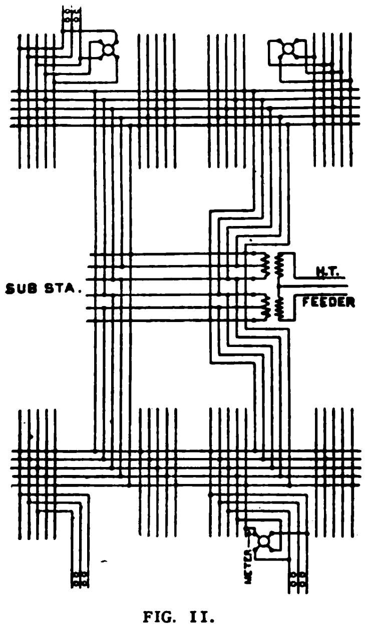

FIG. 11.

While it is theoretically possible to make a sub-station layout which would not require station attendance, this would not be suitable in practice.

We have thus described the possible layouts for alternating-current distribution. By the use of a sub-station with motor-generator sets, we should feel justified in excluding rotary converters; on account of the 60-cycle frequency, we may distribute direct current to an Edison three-wire system covering the underground district with a solid meshed network of mains (Fig. 14).

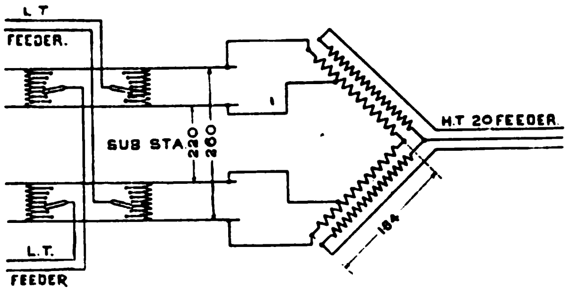

FIG. 10.

(17) By the use of 250-volt lamps and three-wire, 2 x 250-volt mains, existing motors could be operated from the same lighting mains, but we have already pointed out the undesirability of this plan for our conditions—first on account of the low efficiency and higher cost of renewal of high voltage lamps and inferiority of arc lamps, and also on account of making necessary the rewiring of all old customers' buildings.

(18) With two 110-volt mains, the existing 500-volt motors would have to be rewound, but no important changes in customers' wiring would be required. If direct-current distribution were selected, this system, while more expensive, would perhaps be preferable to the 500-volt, three-wire system, on account of the superiority of 110-volt incandescent and arc lamps.

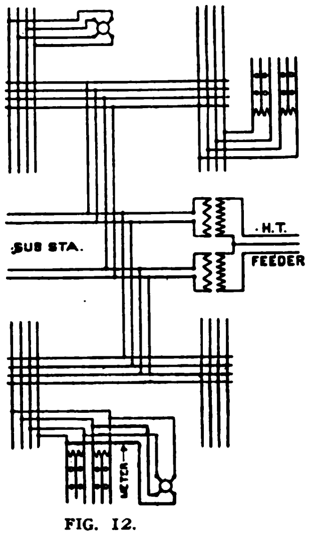

FIG. 12.

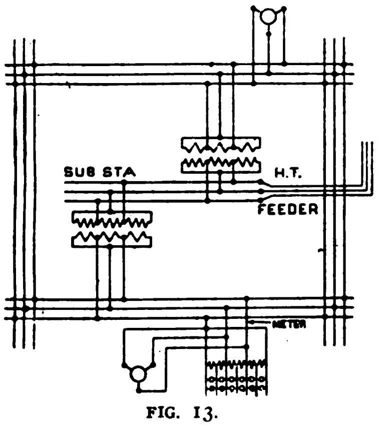

FIG. 13.

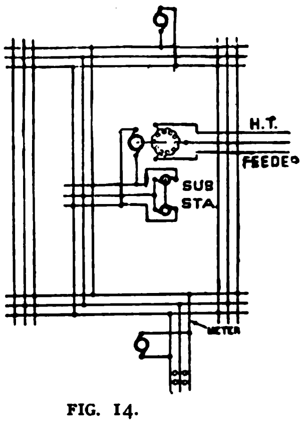

FIG. 14.

For the 18 possible solutions of our problem above outlined we have pointed out a few of the advantages and disadvantages of each system; now by applying some of the general practical considerations we might be able to select among the 18 cases a few that would best suit our conditions. But before proceeding to this elimination we may first figure out the relative economical values for all cases so that our selection may be guided by this requirement as well as by all other requisites of the conditions we have assumed.

In Table I we have given on general lines the main items of cost which are variable for different systems, leaving out of consideration small details and items which would be practically identical for all systems.

The title with the foot notes and comments of Table I explain the assumptions and points to be taken into account in making the comparisons.

The high-tension feeders have been figured for slightly different drops to fit the practical conditions, the lowest being 2.4 per cent and the highest 3 per cent for the length of 5000 ft. assumed in the case. (For larger distances of generating station from distributing centers the line drop and cost of high-tension feeders would be correspondingly increased.) The average maximum line drop of low-tension feeders has been assumed as 11.6 per cent for the 500-volt power circuits, and from 5.2 per cent to 9.4 per cent for low-tension feeders for lighting or for light and power combined. The line drop in mains was in all cases very close to 1 per cent.

The efficiency of transformers at full load has been assumed at 97.5 per cent in all cases, and the efficiency of motor-generator sets at 85 per cent. Column G, giving the maximum load efficiencies, has been worked out from the above figures. The average load efficiencies of column H were estimated for the most favorable conditions.

Table I shows cost of cables and transforming apparatus for 18 possible solutions of the problem of putting underground the present overhead distribution in the business section of a medium size city now supplying 1200 kw, maximum alternating-current lighting 600 kw. maximum, 500-volt direct-current power, to an installation

42,500 equivalent 16-c.p. incandescent and arc lamps, and 1800 horse-power of direct-current motors. The section covers one-half square mile with 69,000 ft. of streets with mains, and its center is assumed to be 5000 ft. from the generating station, equipped with 2200-volt two-phase 60-cycle alternating and 500-volt direct-current generators.

TABLE I.

System.	High-tension feeders.	Low-tension feeders.	Low-tension mains.	Balancing transformers.	Transformers or motor generators.	Total.	Total efficiency of system. At maximum load.	Total efficiency of system. Average all day.
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1 and 2	$34,080	$25,220	$81,110	.....	$8,400	$148,810	91%	91%
3	17,280	25,220	81,110	.....	8,400	132,010	91%	88%
4 and 5	35,500	5,220	95,910	.....	13,000	149,630	93%	92%
6	28,184	5,220	95,910	.....	13,000	142,314	93%	91%
7 and 8	35,500	6,960	71,760	$7,000	13,000	134,220	93%	92%
9	24,835	6,960	71,760	7,000	13,000	123,555	94%	90%
10 and 11	35,500	5,220	66,240	10,000	15,000	131,960	94%	93%
12	24,835	5,220	66,240	10,000	15,000	121,295	94%	90%
13	12,500	56,266	81,110	.....	6,000	155,876	85%	89%
14	18,750	45,632	95,910	.....	9,000	169,292	85%	89%
15	18,750	46,750	71,760	7,000	9,000	153,260	85%	88%
16	18,750	28,180	66,240	10,000	9,000	148,730	86%	89%
17	18,750	18,181	44,505	.....	50,000	131,436	80%	82%
18	18,750	38,900	66,240	.....	50,000	173,922	74%	77%

No. 1, No. 2, No. 3. Mixed systems, single-phase, alternating-current lighting, and small motors with high-tension feeders to 12 transformers feeding low-tension three-wire mains, with 500-volt direct-current power mains.

No. 4, No. 5, No. 6. Single-phase lighting, as before, but alternating current, two-phase power in place of the 500-volt direct-current distribution.

No. 7, No. 8, No. 9. High-tension feeders and two-phase lighting and power from four-wire low-tension mains.

No. 10, No. 11, No. 12. High-tension feeders and three-phase lighting and power from three-wire low-tension mains.

No. 13, No. 14, No. 15 and No. 16. Respectively similar to No. 2, No. 5, No. 8 and No. 11, but with transformers in sub-station and low-tension feeders to mains.

No. 17. 500-volt, three-wire distribution for light and power from sub-station with motor-generator sets.

No. 18. 220-volt, three-wire distribution from sub-station with motor-generator sets.

Before comparing the values in column F, we must make a number of corrections and allowances which could not be readily incorporated in the table. Among the most important are the following:

(*a*) No figures were given for cost of ducts, the difference between the several systems being probably small except in cases where double distributing ducts are required. In the eight cases No. 1 to No. 6 and No. 13 and No. 14, all having five-wire distributing mains, it will be necessary to have double distributers which, figured on an increment cost basis, would amount to, say, $23,000.

(*b*) For cases No. 4 to No. 12 and No. 14, No. 15 and No. 16, distributing polyphase amount for power, we must add the cost of replacing the existing 1800 horse-power of direct-current motors with alternating-current motors. For our estimate we may assume this cost at $50,000.

(*c*) For case No. 17 we would have to rewire practically all the existing customers' incandescent and arc lamp installations at an estimated cost of, say, $50,000.

(*d*) For case No. 18 we would have to rewind or replace all 500-volt motors with 220-volt motors at a cost of, say, $25,000.

In Table II, column F_1, are given the revised values with the corrections (a), (b), (c), (d), added to column F of Table I. For comparing the cost of different systems we must use column F_1 of Table II in the case of existing installations; for the case of new business we must use either column *F* or column F_1, according to whether the new business is for a customer not already supplied with current or otherwise. The importance of existing private plants operating in the territory, the annual rate of increase and the ultimate growth of business will decide which course to take in the comparison. The conditions for the future are, however, in most cases difficult to judge, as they are dependent upon new and unforeseen developments. Therefore, unless a proposition can show more or less immediate advantages on its own merits under existing conditions, we shall assume that it would be entirely speculative and unsafe to follow. In our present case of a medium-sized city, whose business grows at a rather moderate rate from year to year, we feel justified in assuming that the system selected must show substantial immediate advantages under present existing conditions rather than distant future savings. Therefore, while we will give due consideration to the final results, we shall, however, be guided more in our selection by the values given in column F_1 of Table II rather than by the increment values of column *F* of Table I.

To reduce the relative values of efficiencies to a money basis we have assumed a load factor of 25 per cent and figured out the total losses in Table II on the basis of an increment cost of production of one cent per kw.-hour. (With cost of coal very high or very low or with water power plants this figure may be either too low or too high.) In the case of systems requiring a sub-station we have added $3000 for its cost of operation.

TABLE II.

System.	Total cost of system.	Yearly cost of inefficiency losses.	Yearly cost of sub-station operation.	Total yearly cost (M + N).
	F_1	*M*	*N*	*P*
1 and 2	$171,810	$2,500	....	$2,500
3	155,010	3,400	....	3,400
4 and 5	222,630	2,200	....	2,200
6	215,314	2,500	....	2,500
7 and 8	184,220	2,200	....	2,200
9	173,555	2,750	....	2,750
10 and 11	181,960	1,900	....	1,900
12	171,295	2,750	....	2,750
13	178,876	3,100	$3,000	6,100
14	242,292	3,100	3,000	6,100
15	203,260	3,400	3,000	6,400
16	198,730	3,100	3,000	6,100
17	181,436	5,500	3,000	8,500
18	198,922	7,500	3,000	10,500

With the aid of Table II and all that has been previously said, we may now proceed to analyze the several solutions with the view of making the final selection.

Systems No. 4, No. 5, No. 6 and No. 14, the most expensive as to first cost, have no special points of superiority to commend them to us, and we shall, therefore, exclude them from further consideration.

System No. 17, while reasonably economical as to first cost, is inefficient, its losses being only exceeded in one other case; and, furthermore, it requires the operation of inefficient and more expensive high voltage incandescent lamps and unsatisfactory arc lamps. This system is, therefore, unsuitable for our conditions.

Systems No. 3, No. 9 and No. 12 require low investment and are all reasonably economical. The essential feature of all three is the presence of only *one* or *two* high-tension feeders supplying all the current for the underground section, this section being divided in numerous independent districts of distributing mains. There is no question that the resultant economy is accomplished at a heavy sacrifice of the reliability of service, and it is questionable if a similar plan would be given preference when almost as good results could be obtained with the corresponding systems No. 2, No. 8 and No. 11, having several independent high-tension feeders supplying current to one or two solid meshed network of mains. We shall, therefore, have to select from systems No. 2, No. 8 and No. 11. (The systems No. 1, No. 7 and No. 10 are practically identical with No. 2, No. 8 and No. 11, but the latter are preferable if they can be adopted, having a solid meshed network of mains instead of subdivided districts.) Between No. 8 and No. 11 there is, perhaps, little choice. The costs are practically the same; No. 8 transmits two-phase high-tension current, three-wire, which is undesirable, but the line drop being less than 3 per cent this drawback is not serious. It has the advantage over the three-phase system No. 11, that each phase can be regulated a good deal more independently than the three-phase. In our case, having assumed to have two-phase generators at the station, we may give the preference to No. 8 over No. 11. Between No. 8 and No. 2 the differences are of greater moment. With slight differences in first cost and economy system No. 2 has the advantage of supplying direct-current power to motors, which requisite we assumed to be a desideratum in our case.

Between systems No. 15 (two-phase) and No. 16 (three-phase), the differences in favor of No. 16 are too trifling to counterbalance the greater advantage of absolute independent regulation of phases of No. 15. We shall, therefore, discard No. 16.

By successive eliminations we have brought the problem to the selection between four systems, No. 2, No. 13, No. 15 and No. 18. The last three require a sub-station, while system No. 2 does not. If local conditions warrant the direct distribution from the generating station to transformers in manholes or customers' premises, system No. 2 has such marked advantages over the other three systems that its selection would be a matter of course. In case the sub-station is found necessary we must select between No. 13, No. 15 and No. 18. System No. 13 does not give us the desired unification of generating apparatus, but its advantages in first cost and efficiency together with the possession of the requisite of supplying direct current to motor will, without doubt, outweigh the drawbacks of a composite station, especially if we should equip the station, or, if preferable, the sub-station, with a motor-generator set as a tie and a reserve between the two systems. We have arrived at the above conclusions on the assumption that the generating station was within 5000 ft. of the center of the underground district. It is now important to note what difference it would make if the station were not so favorably located. Referring to Table I, we see that only columns *A* and *G* and *H* would be affected. If we assume to use high-tension cables of the same cross-section as before, the cost will increase in direct proportion to the length and the line drop will also increase in the same ratio. The values of *G* and *H* will change relatively in approximately equal proportion, and for the present investigation we shall not need to revise the deductions as far as deduced from the efficiency values of columns *G* and *H*.

The only limitations will be the difficulties of transmitting 500-volt current too great distances and the poor regulation of the alternating-current system with too large line drops. In general, it is improbable that the direct-current generators supplying the 500-volt power service be installed at a station very distant from the center of distribution; it is, therefore, reasonable to suppose that where the alternating current main station is at greater distance than two or two and one-half miles, there is also a direct-current 500-volt subsidiary station near the distributing center. This is by no means a hypothetical case, as we find similar conditions in many places. Let us then assume that the previous conditions were changed to the existence of two generating stations, one direct current at 500 ft. and one alternating current at 15,000 ft. from the center of distribution, all other conditions remaining the same. The larger stations can be assumed to be better situated for operation. We should like, if possible, to discontinue the operation of the smaller stations; the subject will, therefore, require careful study. Let us assume that it has been proved advantageous to do away with the direct-current station by substituting 500-volt direct-current motor generator sets at a convenient sub-station, or transform the 500-volt service if a better solution is available. The polyphase alternating-current system considered before would enable us to do away with the sub-station entirely, but can we still transmit economically the alternating-current to a distance of 15,000 ft., as was the case where the distance was only 5000 ft.? By referring to Table I, column *A*, we find that if we multiply by 3 the values therein given, we obtain the approximate variation in the cost of feeders. This cost for system No. 8 or No. 11, which we have found to be the most desirable for polyphase distribution, would amount to $106,500 for both cases. The cost for high-tension feeders in the corresponding cases, with sub-stations (systems No. 15 and No. 16), would be $56,250, a difference of $50,250 in favor of the sub-station; this without considering the undesirability of very long high-tension feeders for separate district transformers.

We see, then, that after a certain distance, exceeding two or two and one-half miles, the problem of distribution becomes a problem of transmission. In such cases it is necessary to have a step-down sub-station at the distributing center.

For our new problem we shall then have to consider only the systems No. 13 to No. 18, suitably revised.

We may neglect the high-tension feeders to the sub-station, as they will be the same in all cases; from the sub-station we could distribute high-tension current to transformers distributed all over the system, as in cases No. 1 to No. 12, but having to operate a sub-station it would be preferable to attain the advantages of the direct distribution by locating the same at a convenient place, near the center of distribution of the underground district.

With the exception of system No. 13, the other five systems, No. 14, No. 15, No. 16, No. 17 and No. 18, would have the same relative values as in Table II. System No. 13, however, would have to be revised in so far that the 500-volt power cables would be somewhat cheaper on account of the sub-station being nearer the center of distribution than in the previous case. This saving is estimated at $12,000. On the other hand, the cost of motor-generator sets would more than offset this saving; furthermore, it would be necessary to provide some reserve capacity. Making such allowances the net cost of system No. 13 would be increased at least $10,000. Other things being equal, the efficiency at maximum load and the all day efficiency will both be reduced about 3 per cent in each case. Therefore, the relative values of Table II for systems No. 13 to No. 18 will apply to the revised conditions with the exception of system No. 13, for which the total cost (F_1) will be $188,876. The yearly cost of inefficiency losses, column *M*, will amount to $4000, and the total, column *P*, will be $7000, instead of the values given in Table II.

Discarding systems No. 14 and No. 17 for the same reasons given before, we have now left to select between them four systems, No. 13, No. 15, No. 16 and No. 18. Their respective values, columns F_1 and *P*, as revised, are as follows:

System.	F_1	*P*
No. 13	$188,876	$7,000
No. 15	203,260	6,400
No. 16	198,730	6,100
No. 18	198,922	10,500

The maximum difference in investment costs between these systems is less than $15,000, while the difference in yearly costs of operation is $3400. Estimating the total business effected to represent 2,500,000 kw.-hours sold to customers, the maximum difference per kw.-hour would be .14 cent. This would be the amount saved by the polyphase system No. 16, over the straight direct-current system, No. 18. On the other hand, if we compare No. 13 and No. 16, the difference in cost of operation is reduced to $900, or to less than 4/100 of a cent per kw.-hour sold. In view of the preference for the direct-current motor assumed as a premise of our problem, the selection of system No. 13 becomes very evident. A great number of engineers would perhaps go as far as to select the straight direct-current system No. 18, but considering that with system No. 13 one may gradually develop considerable single-phase motor load in small units and save a good deal of the 500-volt cable investment in streets without motors; and as the present prospects of developments of variable speed alternating-current motors are more promising in the single-phase than in the polyphase type, and as the single-phase distribution is superior for operation, for regulation and for cost and maintenance of meters at customers' premises, we would give it preference over the other systems. These figures and these conclusions may be somewhat surprising for two reasons: First, because it is not generally appreciated how an apparently inefficient system like the direct-current system can so closely compete with polyphase alternating-current systems on the very point of total cost of distribution and apart from other considerations of commercial or practical character as to the superiority of either system; second, because these close results appear to apply even to the case of relatively small centers where the density of current supply per foot of street is greatly below the average density found in large cities.

In the case of large cities it is, however, only pertinent to note that high-voltage transmission and the use of 25-cycle rotary converters improve considerably the efficiency over the efficiencies assumed in our case of 2200-volt, 60-cycle motor-generator sets, thereby bringing the total efficiency of the direct-current system much closer to the alternating-current systems. To bear out this point we may compare the relative amount of cable investment per kilowatt, maximum load at generating station for two large companies, one distributing direct current and the other alternating current with distributed transformers. The values, which are based on the pounds of copper in cables and not the cost of cables, are approximately as follows:

	Lbs. copper per kw. max. Alternating.	Direct.
High-tension feeders	114.9	20.5
Low-tension feeders	....	83.2
Low-tension mains	68.7	67.0
Total	183.6	170.7

If one considers that high-tension cables cost considerably more per pound of copper conductor than low-tension cables, it is evident that the comparison would be still more favorable to the direct-current system. This difference is also felt in the maintenance of the system, as even if the life of low-tension and high-tension cables is assumed equal, their scrap value at the time of renewal will be from 25 per cent to 100 per cent lower for the high-tension cables than for the low-tension cables. This will amount to correspondingly higher cost of maintenance of the alternating-current distributing system than for the low-tension system. The higher intrinsic value of the property will also indirectly affect favorably the financial standing of the company, so that it is reasonable to expect that some benefit is derived therefrom in the event of the selling of the property, or in case of making money loans, or even in the market value of the securities issued by the company.

In closing this review of a rather complex and many-sided problem, we cannot omit to at least note the important part played by the storage battery in making the combination of alternating-current and direct-current systems complete and absolutely reliable.

[The foregoing is a paper read at the International Electrical Congress at St. Louis.]

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ILLINOIS STATE ELECTRICAL ASSOCIATION CONVENTION.

The annual convention of the Illinois State Electrical Association was held this year on October 5 and 6, at Decatur, Ill. After the reports of the secretary and treasurer were read and the routine business disposed of, a discussion of insurance rates and fire insurance was taken up. The afternoon of the first day of the session was given over to a consideration of a number of questions filed with the secretary for the "Question Box." Answering the question: "What economy is there in the use of compound as compared with single-expansion engines at pressures of 100 pounds and less?" R. S. Wallace thought at full load about 10 per cent if the engine used is condensing, but not much without condensers; on fluctuating loads the economy was questionable. The precautions necessary in paralleling alternators formed the subject of the next question. F. L. Lucas drew attention to the necessity of being able to adjust engine governors while the engines were in operation, so as to make them take their proper share of the load when driving alternating-current generators in parallel. Regarding methods of voltage regulation which have proven successful when single-phase lighting circuits are distributed across the phases of three-phase machines, when these machines also served highly inductive loads in motors and arc lamps, it was said that an induction regulator accomplished this satisfactorily. In answer to a question of how often switchboard instruments should be tested to insure reasonable accuracy, Mr. Wallace stated that he tested indicating instruments every six months, whereas the integrating wattmeters measuring the total station output were calibrated every two months. G. L. Lukes thought switchboard voltmeters should be compared with a standard of known accuracy every month or two, since the maintenance of correct potential is essential in operation. With ammeters accuracy was usually not so important. "What method of treating wooden poles gives the best result in preserving the tops and butts from decay?" was the next question. Mr. G. C. Kinsman pointed to the fact that the Western Union Telegraph Company with its years of experience did not treat or paint its poles in any way. The average life of Western Union poles, he said, was sixteen years.

The session then adjourned to witness the exhibits of specialties provided by the electrical supply men. The next morning the "Question Box" was again taken up. The connecting of small plants with adjacent towns six or eight miles distant and having a population of from 800 to 1000 was deemed advisable, as in many cases cited this was shown to be both successful and profitable. The joint occupancy of poles by electric light and telephone companies was then discussed. The concensus of opinion seems to have been that this was preferable to having numerous pole lines on the same street. "How often should meters be tested?" was a question which caused much debate. F. L. Lucas thought that once a year was as often as a small plant could afford to test meters. J. F. Gilchrist, of the Chicago Edison Co., thought that for customers having bills of $5.00 per month or less, a yearly test was sufficient. The larger the customer, however, and the more money involved the more frequent should be the tests of the meter.

Officers for the following year were then elected as follows: E. B. Hillman, president; Xenophone Caverno, first vice-president; B. H. Abbott, second vice-president; J. A. Carothers, third vice-president; E. S. Hughes, fourth vice-president; C. A. Vallette, treasurer; D. Davis, secretary. Executive committee, W. B. McKinley, H. E. Chubbuck and S. S. Davis.

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ALTERNATING-CURRENT COMPENSATED VOLTMETERS.

H. W. YOUNG.

The maintaining of a constant potential on alternating-current systems is one of the most important problems which confronts the central station manager.

This is particularly true of lighting systems as the life and candle-power of an incandescent lamp are vitally dependent on the voltage supplied at its terminals. Even a slight increase in voltage above the normal greatly shortens the life of an incandescent lamp, while a decrease in voltage materially lessens the candle power. In order to obtain the best lamp life and maintain a high standard of service, it is necessary that the voltage applied at the lamp terminals be constantly maintained as near the normal as possible.

The average alternating-current station of to-day employs large generating units, each machine usually supplying several districts by means of independent feeders. The business district may be supplied by one feeder of the generator, while another feeder, from the same machine, may supply a residential district, or possibly a summer resort. The load characteristics will therefore be radically different for each class of service, and the peak will occur at different hours on the various feeders.

It will be readily seen that the amount of compounding required on any individual circuit will depend on the condition of load and thus it becomes necessary to give the best service, that some means be provided for regulating the voltage on each feeder in order that constant potential will be delivered at the lamps, regardless of load conditions.

Several forms of feeder regulators have been devised which perform this function very satisfactorily, but in order that the station attendant may correctly manipulate the regulators, it is necessary to employ a voltmeter which will indicate the pressure maintained at the point of distribution. The voltage at the point of distribution can, if the load is non-inductive, be calculated by means of the ammeter and voltmeter readings, when the resistance of the circuit is known, but this method is far from being satisfactory, and is subject to appreciable errors if the load it at all inductive.

A method employed to a large extent in the past, was to run small wires, commonly known as "pressure wires," from the feeder end or center of distribution back to the station; these wires being of sufficient capacity to operate a voltmeter without appreciable loss. Arrangements were made so that the voltmeter could be plugged across the pressure wire terminals and the voltage at the center or end of the feeder determined.

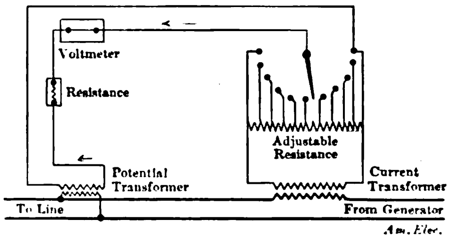

FIG. I.

This method, however, was necessarily expensive, and when carried out to any degree of completeness resulted in a great deal of complication. As the length of feeders increase the cost of installing such pressure wires becomes excessive, and in systems having feeders covering great distances the expense would be prohibitive.

In place of the older methods of calculation or use of pressure wires, a simple, inexpensive and thoroughly reliable device has been developed, by the use of which the pressure maintained at the point of distribution can readily be determined and the potential regulators properly adjusted to maintain the desired voltage.

This device is known as the voltmeter compensator and is made in two distinct types, one being suitable for use on circuits carrying non-inductive loads only, the other for use on either inductive or non-inductive circuits. Several forms of each type have been developed, but only the more important will be considered.

Fig. 1 illustrates a form of voltmeter compensator for use on circuits carrying a non-inductive load. This device consists of a current transformer, an adjustable resistance, and a small pivoted switch, the entire combination being mounted on a common support.

The primary of the current transformer

is wound with comparatively few turns of wire having sufficient capacity to safely carry the entire current of the circuit. The secondary is wound with a much larger number of turns of smaller wire, and gives across its terminals a pressure of about twenty volts with maximum current in the primary. Across the transformer secondary is connected an adjustable resistance provided with a number of taps brought out at equal distances and firmly secured to suitable contact points. A pivoted switch arranged so as to describe an arc coinciding with the contacts makes positive connection by means of a spring backing.

The station indicating voltmeter is connected through the adjustable resistance and pivoted switch, to the secondary winding of a potential transformer, the primary winding of which is connected directly across the circuit. This adjustable resistance is so connected that the drop across it is in opposition to the secondary voltage of the potential transformer, the voltmeter thus indicating the difference between the drop across the resistance, and the secondary voltage of the potential transformer.

As the drop in potential on a non-inductive circuit is directly dependent upon the current, length of line and size of wire, it will at once be apparent that, as the load increases in the primary of the current transformer, the drop across the adjustable resistance increases in direct proportion and a certain pressure is opposed to the pressure of the potential transformer secondary. As the load varies, the value of this opposing voltage increases or decreases, and causes the station voltmeter to indicate a value less than the actual bus-bar voltage. By proper proportioning of the adjustable resistance any desired range of compensation can readily be obtained. As usually supplied for commercial service the resistance is so proportioned that a regulation in 2 per cent steps is obtained. The station attendant adjusts the feeder regulator until the voltmeter indicates the correct pressure to be maintained at the point of distribution, thus eliminating the personal factor which is necessarily introduced when maintaining constant voltage at the point of distribution by the use of pressure wires, or voltmeter and ammeter calculations.

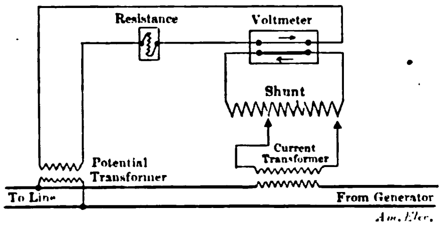

FIG. 2.

The compensator when first installed must be adjusted for the normal operating conditions of the circuit and until these conditions change no further adjustments are necessary. If the line losses are known the device can at once be set for the desired compensation, but when this factor is unknown it is necessary to take voltmeter readings at the center of distribution and adjust the compensator accordingly.

A common method of adjusting the voltmeter compensator is to have readings taken at the point of distribution where normal voltage is to be maintained and the readings telephoned back to the station. The compensator can then be adjusted until its voltmeter reading agrees with the voltmeter on the line. A few trials at different hours of the day will enable the station attendant to closely adjust the device for average conditions.

If desired the indicating line voltmeter can be replaced by a curve drawing or graphic recording voltmeter and a continuous record obtained of the voltage variation. By means of the data obtained the voltmeter compensator can be adjusted as desired.

The compensating device illustrated in Fig. 2 is of somewhat different construction and, like the compensator previously described, is suitable for use on non-inductive circuits only. This device employs a current transformer, a specially wound voltmeter and a shunt having adjustable contact points. The current transformer is external to the voltmeter and shunt, has a primary winding of suitable capacity for the circuit under measurement and a secondary winding having a capacity of approximately five amperes.

The voltmeter is provided with two windings, one consisting of several hundred turns of fine wire, the other having a comparatively few turns of wire capable of carrying five amperes continuously. The terminals of the heavier winding are brought out to binding posts across which is connected the adjustable shunt. The fine wire winding of the voltmeter is connected through an external non-inductive resistance to the secondary of a potential transformer, the primary of which is connected directly across the circuit.

The voltmeter coils are wound in opposition to each other; each coil therefore tending to decrease the field generated by current passing through the other coil. As the value of the current in the secondary of the current transformer is directly proportional to the current in the primary, it will at once be seen that a current directly proportional to the load will flow through the joint circuit formed by the shunt and heavy winding of the voltmeter. The amount of current which passes through the voltmeter portion of the joint circuit is determined by the position of the movable contacts on the shunt, which in turn are governed by the per cent of compensation desired. The indications of the voltmeter and per cent of compensation are therefore dependent upon the relative ampere turns of the two windings. Like the compensator illustrated in Fig. 1 it is necessary to adjust this device for the normal conditions of the circuit, but it requires no further attention until these conditions change.

The devices illustrated in Figs. 1 and 2, therefore, give readings on the voltmeter which decrease in proportion to the current which is in phase with the e.m.f.; but as a rule inductive drop cannot be neglected and errors of more or less magnitude are introduced. If the load is composed of incandescent lamps only, the inductance will be of small value, but if fan motors, arc lamps, inductive power motors, etc., are also connected, the inductance is correspondingly increased, and the fall of potential is no longer in proportion to the current flowing. It is necessary for such service to provide a compensating device which will enable the voltmeter to accurately indicate the pressure at all times regardless of the current or character of load. Such a device must also have means of adjustment for circuits in which the ohmic or inductive drop is variable.

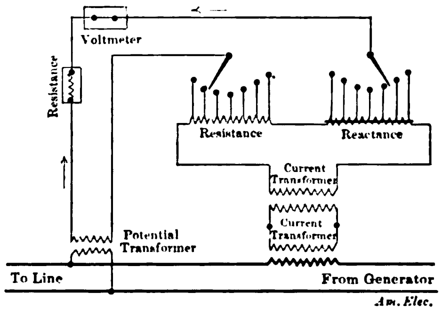

FIG. 3.

Fig. 3 illustrates a compensating device which meets these conditions. By its use the station voltmeter indicates the actual voltage maintained at the point of distribution regardless of the condition of load, that is, current, resistance, reactance and power factor all being taken into account.

The device consists of three elements as follows: A current transformer, a resistance and a reactance, both of the latter being adjustable in value. These elements are all contained in a suitable frame arranged for mounting on the switchboard.

The secondary of the internal current transformer is connected in series with the resistance and reactance, and the primary connected to the secondary of an external current transformer, the primary of which is connected directly in series with the load. This external transformer has a secondary winding giving a current of approximately five amperes and is usually one of the standard transformers operating other switchboard instruments or meters. The small internal transformer is wound to give approximately one ampere on the secondary which permits the use of small reactance and resistance coils, thus keeping the watt loss of the device at a low value.

As will be noted from the illustration, taps are brought from the reactance and resistance to small contact points over which travel pivoted switches. One switch is connected to the voltmeter and the other to the secondary of a potential transformer, the primary of which is connected across the circuit. The current and fall of potential across the resistance and reactance are dependent upon the load in the main circuit and the connections to the voltmeter are so arranged that the fall of potential across them is in opposition to that of the potential transformer, the voltmeter thus indicating the difference of the two potentials. A local circuit having characteristics practically identical to the main circuit is therefore produced, as the reactance takes care of the inductive, and the resistance of the ohmic drop. Any change in the main circuit will instantly produce a similar change in the local circuit and be immediately indicated by the voltmeter. The station attendant can then adjust the regulating devices until the voltmeter again indicates the voltage to be maintained at the center of distribution. The per cent of compensation is determined by the position of the pivoted switches more or less potential being opposed to the voltage of the potential transformer as found necessary.

The compensated form of voltmeter will undoubtedly find great favor among electrical engineers and central station managers. The devices in Figs. 1 and 2, while extremely useful are by nature of their construction necessarily limited in application, and the majority of distributing systems will require the device illustrated in Fig. 3. The fact that the compensator can be used on any system, and is accurate on varying loads, regardless of the power factor, is a feature which will appeal to all users of electrical apparatus. It can safely be predicted that but comparatively few new alternating current lighting systems will be installed without voltmeter compensators, and many of the present systems will undoubtedly also be essentially equipped with these useful devices.

CONVENTIONS OF THE AMERICAN STREET RAILWAY ASSOCIATION AND AFFILIATED ORGANIZATIONS.

The conventions of the American Street Railway Association at St. Louis, and its affiliated bodies, the American Street Railway Mechanical and Electrical Association, and the Street Railway Accountants' Association of America, were among the largest ever held by these associations, the registered attendance at the Street Railway Association's convention alone being over 1100. The sessions of the Mechanical and Electrical Association opened on Monday, October 10, with E. W. Olds in the chair. J. I. Beggs, president and general manager of the Milwaukee Electric Railway & Light Company, delivered an address and recommended the consolidation of the organization with the parent body and the reorganization of the latter. W. C. Ely, president of the International Traction Company, of Buffalo, spoke of the possibility of the parent organization taking over the Electrical and Mechanical Association and paid a high tribute to the master mechanic.

F. G. Simmons reported that trackmen were desirous of joining the association and the by-laws were accordingly changed to permit this addition to membership. In the afternoon W. D. Wright read his paper on "The Ideal Shop," which was followed by J. Millar's paper on "Wheel Matters."

At the session on Tuesday John Lindall's paper on "Maintenance and Inspection of Electrical Equipment" was read by A. Green. The author laid stress upon systems of written reports and proper tabulating and recording of defects. He also referred to the excellent results obtained by training motormen, electrical inspectors and repairmen. After the appointment of a committee on cars and car equipment, the shop, car stations, track and block signals, the association proceeded to the election of officers, which resulted as follows: President, C. F. Baker; vice-presidents, H. H. Adams, Baltimore; J. Millar, Buffalo; Fred G. Simmons, Milwaukee; secretary, W. Mower, Detroit; executive committee, B. F. Carver, Newark; J. S. Doyle, New York; C. C. Lewis, Schenectady; W. H. McAloney, Denver.

The first session of the Street Railway Association was held on Wednesday, October 12, President Francis, of the Exposition, making the opening address, to which President Ely, of the association, responded. Prof. Goldsborough followed with an address in which he pointed out the features of the Exposition of special interest to street railway men. Mayor R. Wells, of St. Louis, then welcomed the convention, after which President Ely delivered his presidential address.

In this he reviewed the important work of the electric railway field principally with respect to heavy traffic. A considerable portion of the address was devoted to the subject of the reorganization of the association. There were already two subsidiary organizations and it had been proposed to create a third having for its membership electric roadbed engineers and superintendents. President Ely thought that this could not go on indefinitely, for with a large number of organizations, each pursuing its solitary way unmindful of the others, there would finally be chaos. He therefore considered it vitally necessary to take up the matter of reorganization, and suggested that this be referred to a committee on which the several affiliated bodies would have a representative.

Several technical papers were read at Thursday's session, two of these being on the steam turbine. One was written by R. H. Rice and the other by J. R. Bibbins, and both elicited considerable discussion. Replying to a query, Mr. Rice said that the commutators of the Curtis turbine run dry, lubricating brushes being used, and that the commutator bars are secured by nickel-steel rings shrunk on over insulation. S. M. Hopkins said that in Columbus, Ohio, there was a 500-kw. turbine connected at the end of a steam line, and that while there was a large amount of steam condensed in the steam pipe, sufficient in fact to make it almost impossible to start a small exciter engine, no difficulty was experienced in starting the turbine. Comparative tests, however, made on two 500-kw. turbines and two tandem reciprocating engines showed these latter machines to be more efficient. W. H. Abbott, of Cleveland, said that his company was operating two 1500-kw. turbines with steam superheated 50° to 100°, and that water was present at times in fairly large quantities in the steam pipe. This Mr. Mailloux explained was due to water entrained mechanically. He said that turbine builders did not claim the highest economy under all conditions, and cited the case of a 5000-h.p. triple expansion, four-cylinder, Swiss reciprocating engine at Berlin, which at nearly full load had developed a horse-power-hour for something less than 9 pounds of water with superheat up to 600° or more. This engine, however, had 16 valves and complicated mechanism requiring much lubrication. There was a critical price for coal, he said, at which the turbine is not preferable to the reciprocating engine.

On motion a committee of nine members was appointed whose duty is to endeavor to increase the membership of the association. The duties of the secretary were also enlarged so as to require his entire time. The following officers were elected: President, W. Caryl Ely (re-elected); first vice-president, Elwin C. Foster (re-elected); second vice-president, John I. Beggs; third vice-president, Richard McCulloch; secretary and treasurer, T. C. Pennington; executive committee, the president, the vice-presidents and John J. Stanley, Howard F. Grant, C. G. Goodrich, Frank G. Jones and W. E. Harrington.

Abstracts from Foreign Contemporaries

Automatic Transformer Switches.—J. Schmidt describes in a recent issue of the *Elektrotechnische Zeitschrift* a transformer switch designed by the Siemens-Schuckert Works for automatically interrupting the primary and secondary circuits of a transformer whenever the current consumption on the secondary side falls below a predetermined amount. This arrangement permits a low-tension circuit to be fed by a continually varying number of transformers, the number at any instant being automatically regulated to give the most economical results. The switch contacts are mounted on three upright grooved porcelain bodies, the middle one being free to turn. Rotating this middle portion one way or the other effects the opening or closing of the switch. Springs are interposed in the mechanism in such a manner that both the opening and the closing of the contacts is done quickly. The operations of switching on and off are controlled by a device similar to that often used for regulating alternating current arc lamps. This device consists chiefly of an aluminum disc, upon which a torque is exerted by two magnetizing coils, one of which is connected in series with the secondary circuit, while the second one is energized in shunt. The torques corresponding to the two magnetizing coils are opposed to each other, and may be regulated in strength not only by varying the windings of the coils, but also by shifting their position relatively to the disc. It is obvious, therefore, that the disc may be made to turn one way or the other when predetermined conditions as to load exist. If the current in the secondary circuit drop, for instance, below a certain point, then the torque arising from the action of the shunt coil overcomes the less powerful torque relating to the series coil. Consequently, the disc turns in a certain direction, and in doing so closes an auxiliary circuit. A small magnet is thereby made to attract an armature, this in its turn causing the main switch to open against the pull of a spring. If the load in the secondary increases above a given value, the disc turns in the other direction. Another auxiliary circuit is closed, a catch is released, and the switch is closed by the force of the spring which previously had been compressed. Fig. 1 shows the switch applied to two three-phase transformers. *A*, A_1 and A_2 are high-tension feeders, *B*, B_1, B_2, *C*, C_1 and C_2 being high-tension distribution cables. The low-tension bus bar N_1 is divided into two parts *A* and A_1 the transformers being connected to the former side and the distribution lines being connected to the latter side; both halves of the bus are, however, electrically connected by the wires *l* and *m*, which energize the magnet *b* of the relay. In order to illustrate the manner in which the device works, suppose the transformer *I* to be designed for a secondary load of 100 amperes and the relay to be set for 80 amperes. Should the load fall below 80 amperes, the magnet *a* becomes more powerful than magnet *b* and the disc *c* revolves so that the contact *g* on the lever *e* makes electrical connection with contact *i*. A circuit is then completed through the transformer, conductor *G*, terminal *o*, fingers *π ρ*, terminal *σ*, conductors *G'* and 19, terminal 20, conductor 1, lever *e*, contacts *g* and *i*, conductor 9, terminal 10, conductor 11, terminal 12, electromagnet *x*, terminal 13, conductor 14, terminal 15, conductors 16 and *H*. The excitation of the magnet *x* causes it to attract the armature *w*. opening the switch, thereby cutting out transformer II.

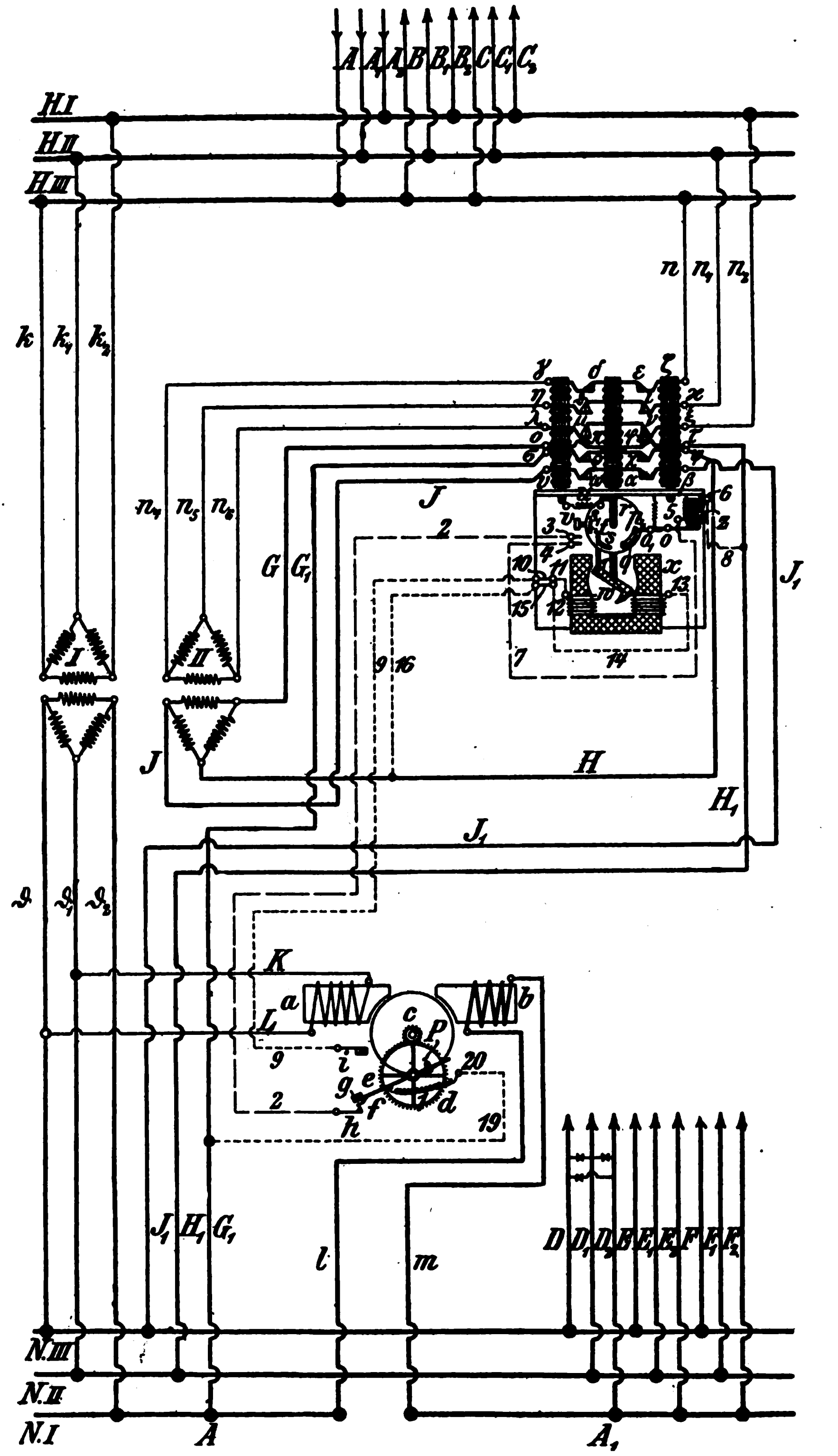

FIG. 1.—AUTOMATIC TRANSFORMER SWITCH APPLIED TO THREE-PHASE TRANSFORMERS.

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Novel Arrangement of Steam Mains.—In the Willesden power house of the North Metropolitan Electric Supply Company, a description of which appears in our English contemporaries, the arrangement of the steam mains is somewhat novel. Each boiler serves one engine directly. The equalizer main does not run straight across the boilers, however, but is made up of separate lengths serving two boilers, one above the back of the boilers, the next over the center, and so on. These are joined by a connecting pipe at right angles to them through wide bends. This allows ample room for expansion of the pipe without the intervention of expansion bends, and it is the regular practice at the works to shut off the equalizer main when it is not required, in spite of which no trouble is experienced with the joints. To guard against water-hammer, a separator is placed at each connection between the equalizer main and the boiler, in addition to the separator placed, as usual, at each engine. The piping is of steel throughout. Contrary to the usual arrangement, the low-pressure cylinders, instead of the high-pressure cylinders, are nearest the boiler house. This puts the condensers in a convenient position against the wall of the boiler house, and there is, moreover, practically no extra length of steam main, as this is carried from the separator to the high-pressure cylinder through the receiver between the two cylinders, which is thus heated with live superheated steam.

A New Crossley Oil Engine.—A recent and fruitful development of the internal combustion motor is its adaption to the use of crude oils, or oils of a specific gravity that precludes their use in motors of the ordinary type. Although experiments on this kind of engine have been in hand for several years, says *The Engineer*, of London, we believe we are not far wrong in saying that it is only within the last eighteen or twenty months that really satisfactory designs have been reached. One of these is illustrated herewith, and, like all engines suitable for crude oil, provision is made for the injection of water into the cylinder before compression. This has the effect of allowing of a much higher compression without pre-ignition than is ordinarily possible, and it has other effects, which are not very fully understood; at any rate, they are frequently discussed. The engine works on the "Otto," or four-stroke cycle, and will use the crude, heavy, black petroleum oils and the semi-refined or intermediates, as well as the ordinary refined lamp oils. The consumption of fuel in these engines is, it is said, only about three-quarters of a pint per brake horse-power per hour. The working of the engine will be readily understood on referring to the accompanying illustrations. On the suction stroke of the piston air is drawn into the cylinder through the main air valve, and the oil is pumped through the oil sprayer into the vaporizer, which receives a further supply of air through a snifting valve. At the same time water is pumped through the water sprayer and enters the vaporizer. This charge is then compressed, and, as the crank of the engine passes the inner dead center, is ignited by the hot ignition tube, giving the working stroke. The exhaust valve then opens to allow the burnt charge to escape, after which the cycle of operations is repeated. The ignitions are continuous on all loads, and the ignition tube is therefore retained at the required temperature without the aid of a lamp except when starting the engine. The speed of the engine is governed by varying the amount of oil and water injected in such a manner that on heavy loads full charges of oil and water are delivered, whereas on light loads only small charges are given. Engines which ignite their charges automatically without a lamp have usually only a low compression. On this engine, however, the compression is comparatively high, the indicator cards showing 75 lbs. per square inch, and over 100 lbs. per square inch is being successfully used in some cases. Vaporizers are usually constructed with some form of cover to prevent cooling. In this engine it will be noticed that no covers are used, and that, on the contrary, cooling ribs are cast on the vaporizer to dissipate as much heat as possible by radiation. Further cooling is also effected internally by the water spray. Engines on this principle have been constructed in powers ranging from 2 to 47 brake horse-power, and larger sizes are being designed.

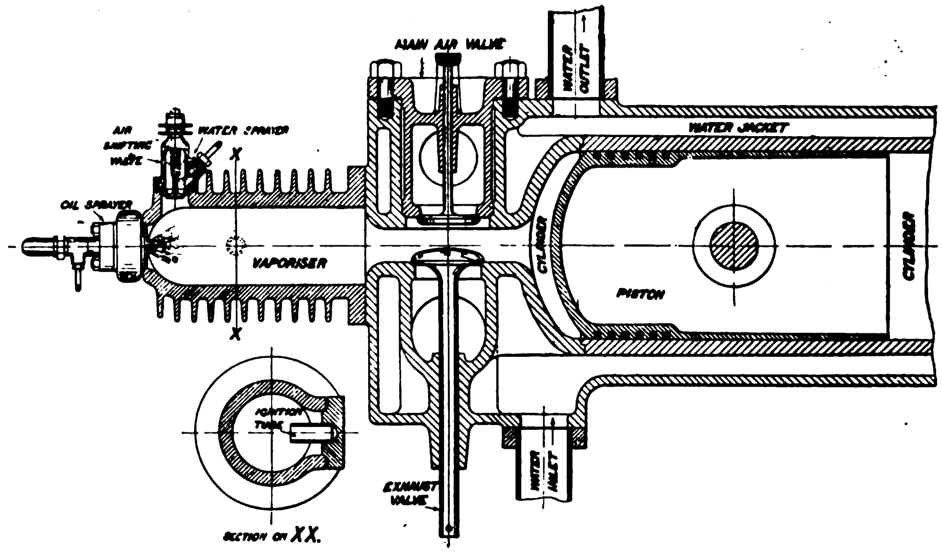


FIG. 2.—SECTION OF NEW CROSSLEY OIL ENGINE

Improvements in Gas Engines.—The London *Mechanical Engineer* describes some improvements in gas engines made by the firm of Fried. Krupp, of Essen, Germany, and patented in Great Britain. The patent relates to gas engines in which the valve chests are placed on the back of the cylinder, the object being so to construct the valve chests for such engines that splitting of the valve chests and cylinders is effectually prevented. The desired end is attained by surrounding the valve chests with a cylinder jacket in the form of a water chamber, so that they are surrounded by the cooling water, and consequently no excessive accumulation of heat can take place at any point. Fig. 3 shows, by way of example, an application of the invention to the inlet and outlet valves of a double-acting, four-stroke cycle engine. The working cylinder, *A*, which is surrounded by the cylinder jacket, *B*, has at each end upon its back a flanged junction, a_1. Upon each of these junctions is mounted a valve chest, *C*, of trough shape, and having a corresponding junction, c_1. At the other end the chests are provided with ribs, c_2, which bear against ribs, a_2, of the cylinder, but are not rigidly connected thereto, so that the chests, *C*, can expand freely during fluctuations of temperature. The chests, *C*, are closed above, with the exception of the openings in each for one inlet valve, *D*, and one outlet valve, *E*. The cylinder jacket, *B*, extends as far as the valve boxes, D_1E_1, and thus forms a space surrounding the chest, *C*, in which the cooling water can completely pass round it, so that no excessive accumulation of heat is to be feared.

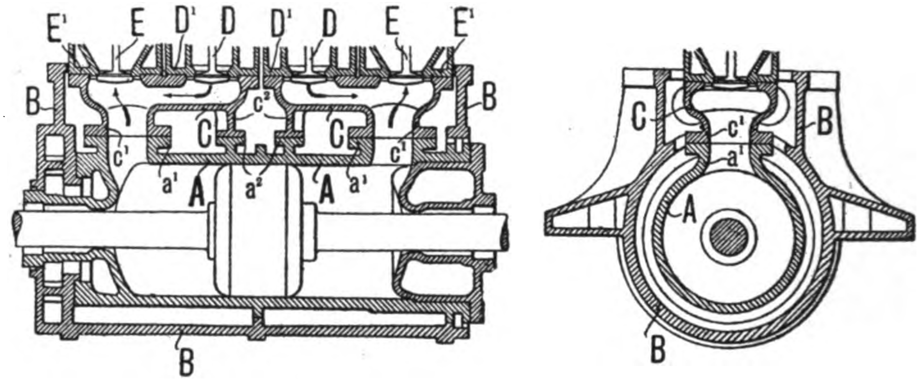


FIG. 3.—CYLINDER OF DOUBLE-ACTING, FOUR-STROKE CYCLE GAS ENGINE.

A New Cable Grip.—A novel manner of drawing cables is described in a recent number of *The Electrician*, of London. The cable grip is shown by Fig. 4; 7/22 galvanized-steel wire is used in its construction and it enables the cable to be drawn without the lead sheathing being cut, as is usually the case. Most engineers will at once appreciate the enormous strain upon the grip which holds on with such tenacity that either the rope or the cable will have to give way before a failure in drawing can occur, as, on account of the construction of the grip, the greater the pull the more securely it holds. Although the severest strains have been put upon the grips they have given every satisfaction, and have come out of the ordeal successfully.

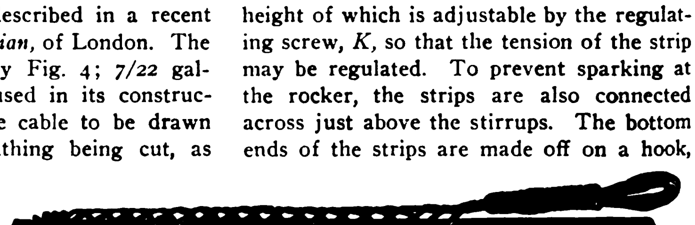


FIG. 4.—NOVEL CABLE GRIP.

New Arc Lamp With Hot-Wire Control.—The London *Electrician* describes the latest form of Foster arc lamp shown by Fig. 5 herewith, the distinctive feature of which is the hot-wire control in place of the ordinary solenoid control, which enables the lamp to be used on either alternating or direct-current circuits. The current enters at the positive terminal, shown dotted, and passes down the lead, *S*, to the post, *V*. To this post there is attached two pairs of metal strips, *R R*, the expansion and contraction of which control the feed of the carbon. The upper ends of the strips are fixed to the stirrups, *N N*, which are hung from the rocker, *M*, on the post, *L*, the height of which is adjustable by the regulating screw, *K*, so that the tension of the strip may be regulated. To prevent sparking at the rocker, the strips are also connected across just above the stirrups. The bottom ends of the strips are made off on a hook, *T*, from which connection is made by a flexible wire, *D*, covered with glass beads, to the upper carbon holder, *Q*, which is free to slide in the tube, *P*. This carbon holder is merely a split tube, and the positive carbon is simply pushed home into it. The circuit from the negative or lower carbon is through the carbon holder, *Y*, the bottom rods, *H H*, and the negative lead, *A*, to the negative terminal. When current is turned on, the strips expand; and, as the bottom hook, *T*, is fixed to the end of a rigid strut, *B*, pivoted at its top end, the hook is pulled over to the left by the spring, *C*, acting through the disc, *F*, and the link, *E*. As the disc rotates it moves the lever, *U*, shown dotted in the drawing, and this brings into action the clutch, *W*, lifting the positive carbon and striking the arc. There is a certain amount of play between the link, *U*, and the disc, *F*, so that the wire is allowed to attain a fairly high temperature before the arc is struck. With a diminished current the heated strip shortens and the disc is turned back slightly, allowing the carbon to feed. Should the feed of the lamp prove to be too fast or too slow in working, this may be adjusted by turning the screw, *K*, already referred to, by means of which the tension of the strip can be slightly varied. It may be noted that the lamp is entirely fireproof in construction, and that it contains no solenoid or dashpot. A steatite ring, *G*, held in place by the screwed bush, *X*, guides the upper carbon, *N*, when the lamp is trimmed, and the clutch is lined with the same material. To facilitate trimming, the pointed end of the carbon is used uppermost. The lamp is of the single-globe pattern, the arrangement of the globe carrier, *Z*, and globe dashpot, *J*, to prevent air leakage being clearly seen in the drawing. The illustration being to scale, it is seen that the lamp is small and compact; its weight is only 12 pounds.

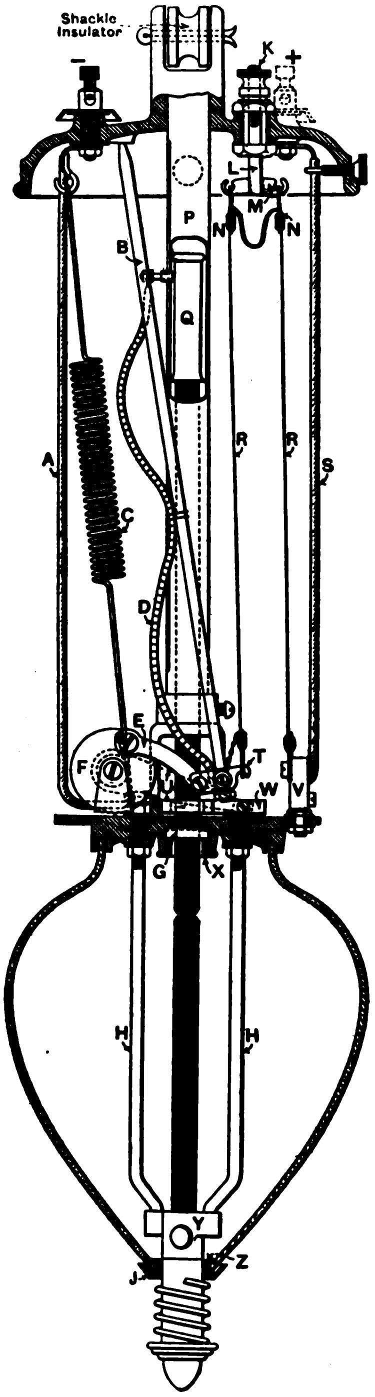


FIG. 5.—FOSTER ARC LAMP.

SOME RECENT ELECTRICAL PATENTS

Remote Switch Control. — Fig. 1 herewith illustrates diagrammatically a rather ingenious system of remote control for switches, applicable, however, only to a three-wire system of supply and patented by John L. Hall nad Howard R. Sargent, of Schenectady, N. Y. At each switching point is located a polarized relay, *C*, which controls the exciting circuits of a double magnet, *B*, adapted to close and open a switch, 15, according to the excitation of the windings. The polarized relays are all connected in series between the neutral wire of the distributing system and the middle point of a two-way single-pole switch, *A*, located at the station or other point of control. Closing the switch, *A*, in one direction will send current of one polarity through the polarized relays, causing each of them to close one of the magnet exciting circuits; if the relay armatures close to the left, the upper coils of the magnets will be energized and the disc-shaped armatures will be raised, opening the switch contacts, as shown in the diagram. Closing the switch, *A*, in the opposite direction puts current of opposite polarity through the relays and they then close the exciting circuits of the lower magnet coils, causing the magnets to close the switch contacts. When the switch, *A*, is open, the relay armatures are held in the mid position by springs. The weight of the switch arm, 11, is sufficient to hold the magnet armature up and keep the contacts open after the magnet has operated, and when the

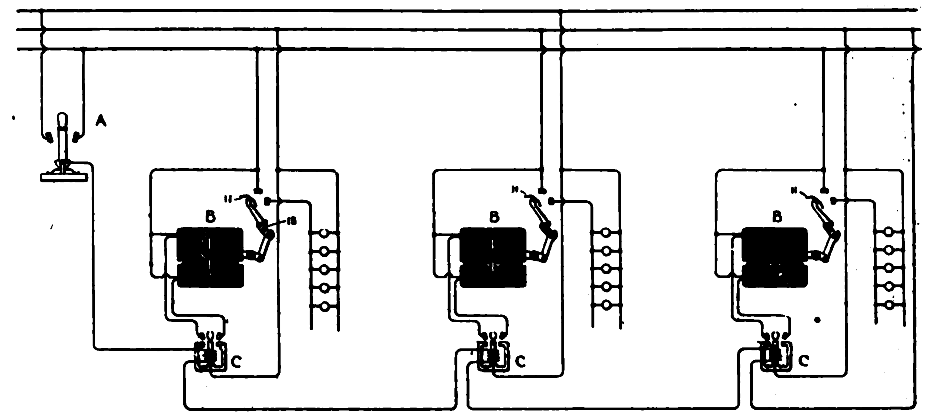
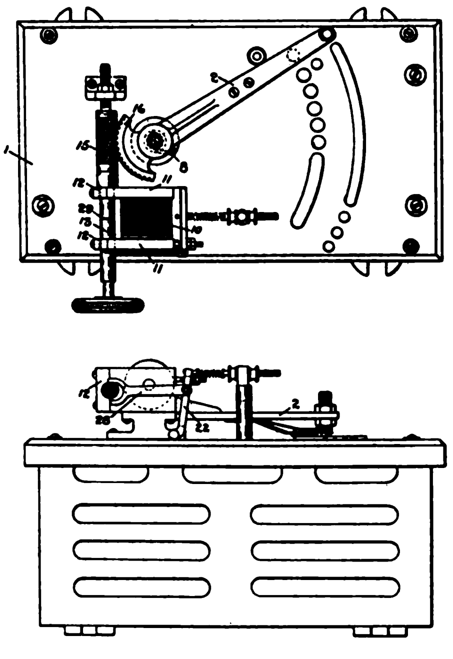


FIG. 1.—REMOTE SWITCH CONTROL FOR THREE-WIRE SYSTEMS.



FIGS. 2 AND 3.—MOTOR SPEED CONTROLLER.

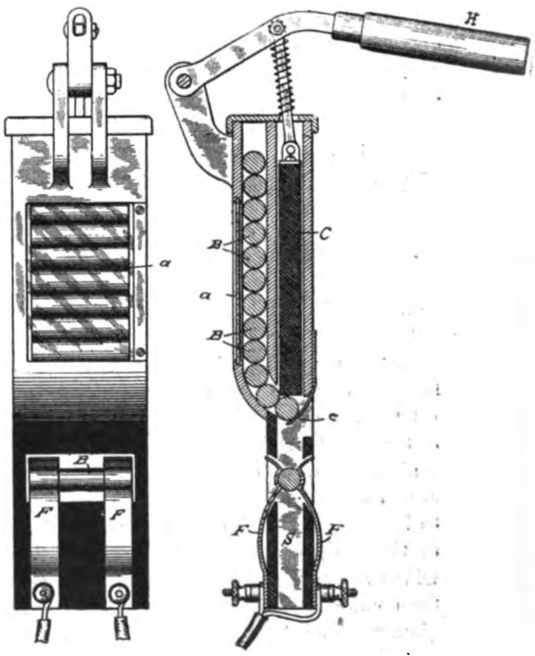


FIG. 4.—MAGAZINE FUSE BLOCK.—FIG. 5.

switch has been closed by the bottom magnet coil the toggle is in a straight line and therefore holds the switch closed after the magnet coil has been de-energized. Consequently it is unnecessary to keep the switch, *A*, closed in either direction. Patent No. 766,391.

Motor Speed Controller. Figs. 2 and 3 illustrate a form of motor speed-regulating controller having automatic overload and undervoltage release that has been patented by M. M. Wood and Henry Geisenhoner, of Schenectady, N. Y. The rheostat arm, 2, is moved by means of a spiral gear, 15, on a transverse shaft, and a segmental rack, 16, on the heel of the arm. The transverse shaft, 13, is of magnetic material in two parts, which are joined mechanically by a non-magnetic piece, 29, set in. This is to prevent the shaft from short-circuiting the poles, 11, 11, of the magnet, 10, to which it is partly journaled. The journal caps, 12, are of brass, so that the magnet poles pull the shaft, 13, tightly against their halves of the two journal boxes. The magnet coil is connected, presumably, in the motor armature circuit. The arm, 2, is provided with a retracting spring, 8, which tends to throw it to the "off" position. While the motor is operating normally, with the arm, 2, in any position of its travel, the magnet holds the shaft, 13, against its poles and thereby prevents the spring, 8, from pulling the arm, 2, to zero. Should the circuit be opened, the mechanism is, of course, released and the arm is returned to zero. Should an excessive current flow in the motor circuit, the magnet attracts the armature, 22 (see Fig. 3) and by means of the bifurcated lever, 28, pushes the shaft, 13, away from its poles, relieving the friction at the journals and allowing the spring to return the arm, 2, to zero, or the "off" position. Patent No. 771,958.

Magazine Fuse-Block.—Several forms of magazine fuse block have been devised, some in which the melted fuse is replaced automatically by semi-automatic apparatus actuated manually. The present invention belongs in the latter class, and is adapted for the use of enclosed fuses. The inventor is Herbert G. Addie, of Cresco, Iowa. Fig. 4 shows a front elevation of the magazine and Fig. 5 a vertical section from front to back. The fuses, *B, B*, etc., are contained in the front compartment of the magazine, which has a glass window, *a*, through which the condition of the supply may be seen at a glance. The "live" fuse is held between metallic clips, *F, F*. When it blows, the handle, *H*, is depressed, causing the plunger, *C*, to push the lowermost fuse, *e*, in the magazine downward and between the clips, *F, F*. The entrance of the fresh fuse into the clips forces the spent fuse out and it drops through the slot, *S*, out of the case. Patent No. 772,200.

CENTRAL STATION ENGINEERS.

I.

John William Lieb, Jr.

John William Lieb, Jr., was born in Newark, N. J., on February 12, 1860. His early education was acquired at the Newark Academy and at the Stevens High School, Hoboken, N. J. In 1880 he graduated from the Stevens Institute of Technology, receiving the degree of Mechanical Engineer. Immediately after his graduation he entered the employ of the Brush Electric Company, of Cleveland, Ohio, as a draughtsman. He remained here less than a year, entering the employ of the Edison Electric Light Company, of New York, in a similar capacity in 1881. In 1882 he was transferred from this company to the experimental department of the Edison Machine Works. He assisted in the tests of the first "Jumbo" direct-connected Edison dynamos, and was put in charge of the installation of the electrical equipment of the old Pearl Street Edison station by Mr. Edison, Mr. C. L. Clarke being chief engineer at that time. Mr. Lieb assisted in the tests and experiments incident to the starting up of this pioneer station, the first commercial station in the United States to supply current for incandescent lighting and power from an underground system, and on the inauguration of regular service September 4, 1882, under the auspices of the Edison Electric Illuminating Company, of New York, was appointed its chief electrician.

JOHN WILLIAM LIEB, JR.

A syndicate of Italian capitalists, with Prof. Colombo as technical adviser, having purchased the complete equipment of boilers, engines, dynamos and Edison underground system for Milan, Italy, Mr. Lieb was selected by Mr. Edison to direct the installation. The Milan station, equipped with B. & W. boilers, Armington & Sims engines and Edison "Jumbo" dynamos, began regular service in 1883 and Mr. Lieb remained in charge as manager on the organization of the Italian Edison Company. He was appointed in turn its chief electrician, director of stations and chief engineer in general charge of the technical department of the company, engaged in manufacturing electrical apparatus, installing isolated plants and constructing and operating lighting and power stations throughout Italy.

Mr. Lieb's company was among the very first to exploit the alternating-current system, beginning with a plant in Milan, Italy, in 1886, and using also the Thomson-Houston arc light system extensively. His last work in Italy was in the electric railway field in connection with the installation of the trolley system in the city of Milan.

Offered an appointment with his old company—the Edison Electric Illuminating Company, of New York—he returned to New York in 1894, at first in the capacity of assistant to the vice-president, and advancing by steps to third vice-president and general manager. On the consolidation of various lighting interests in New York City, under the corporate name of the New York Edison Company, Mr. Lieb was appointed third vice-president and associate general manager, which position he now holds. He is also president of the electrical testing laboratories and director in several electrical corporations.

Mr. Lieb is president of the American Institute of Electrical Engineers, a member of the council of the American Society of Mechanical Engineers, a member of the American Society of Civil Engineers, past-president of the Association of Edison Illuminating Companies and the New York Electrical Society, second vice-president of the National Electrical Light Association and member of a number of national and foreign technical societies.

NOTES.

Ohio Society of Mechanical, Electrical and Steam Engineers will hold its ninth annual meeting at Canton, Ohio, on November 18 and 19. Ten papers of practical engineering value are to be read, and there will be interesting topical discussions. Visits will be made to the factories of the Dueber-Hampden Watch Works and the Russell Engine Company at Masillon.

Revision of the National Electrical Insurance Code.—The annual meeting of the Electrical Committee of the Underwriters' National Electric Association will be held at the rooms of the New York Board of Fire Underwriters, 32 Nassau Street, New York, on Wednesday, December 7, 1904, at 10 a.m. As in the past, the meetings will be open to all interested in the matter of rules for the installation of electric wiring and apparatus as contained in the National Electrical Code. Reports of committees and all suggestions for changes in the Code to be acted upon at this meeting should be in the hands of the secretary by November 5, in order that they may be put into print for the meeting.

A Highly Novel Method of paving the way for new business has been adopted by the Denver Gas & Electric Company. A series of cards, each containing some error in spelling or diction or an obscure verse, is mailed to persons whose patronage is desired. This is followed up with a circular letter calling attention to the cards and stating that a representative of the company will call at any time named by the recipient and will present him or her with a souvenir spoon for any error detected in the matter on the cards. A postal card is enclosed with this letter on which the prospective customer has only to fill out the appointment and signature. It is needless to say that, when the representative calls, he does not put in every minute of his time congratulating the householder on the detection of errors in spelling or diction.

The Pratt Institute Free Library, Brooklyn, N. Y., has just opened to the public an applied science reference room, devoted to technical and trade literature. It is desired to make this department as useful as possible to the practical men engaged in the various trades and industries. The room contains books, bound periodicals and current periodicals. It is in charge of Mr. Herbert L. Cowing, a graduate of the Mechanical Engineering course of Cornell University. The room is open every day from 2 till 6, and on Monday, Wednesday and Saturday evenings until 9.30. A cordial invitation is extended to all who are interested. The management wishes to form a collection of trade catalogues and bulletins bearing upon all branches of industry. These catalogues will be accessible to the public, and it would be glad to receive them from any of the advertisers in or readers of the AMERICAN ELECTRICIAN.

A New Process of Electrical Rail Welding.—The Accumlatorenfabrik A. G., Hagen, Westphalia, is developing a process of electric rail welding patented by Mr. Pahdi, which unlike American methods involves the use of electric arcs produced between a rail that is connected to one terminal of the electrical circuit, and a carbon electrode connected to the other terminal. No metallically-clean welding surfaces are necessary and no riveting of the rails is required. Two carts are sufficient to carry out the process, one of the carts containing a railway motor fed from the aerial line at 550 to 600 volts and driving a dynamo of 65 volts e.m.f., while the other cart carries a "buffer" battery connected in parallel to the dynamo and proportioned so that only about 30 amperes can be drawn from the aerial wire in welding. Cables convey the current to the welding point, where a thin wrought iron plate 9 cm. (3.5433 ins.) in length with lateral bolt staples is placed beneath the lifted rail joint and the joint filled up with a little surplus on top. The material of the rail foot is afterward melted together on both sides with the plate placed below by means of the electric arc, while adding some Swedish charcoal iron. After next surrounding the rail head with two small iron moulds, melting the material of the rail head over a breadth of about 3 mm. (0.118 in.) and supplementing the deficit by Swedish charcoal iron and finally by small ingot iron pieces, a dense welding is obtained by hammering from above. About 3.5 kgs. (7.7 pounds) of additional material is used at all. Between the head and foot weld a place is left free so as to prevent any existing crack from passing throughout the whole. About 40 minutes is required for making a weld, and the power taken is 15 kilowatts. A paper recently read before the Association of German Engineers stated that about 500 welds which have given entire satisfaction have been made since July of last year. Tests are said to have shown the strength of the material at the weld to be practically equal to that of the sound rail.

A Splendid Address was delivered by Mr. Walter C. Kerr to the graduating class of Stevens Institute of Technology at the commencement exercises this year. The address constitutes one of the best advisory efforts of which we have knowledge. Following are a few extracts from it:

"We hear much about opportunities. They are everywhere plentiful. Remember, that your opportunity is the little one that lies squarely in front of you, not the larger one which you hope to find farther along. Many a man is surrounded with opportunities who never seizes one. There are traditions that Adam, William Tell and Sir Isaac Newton each had an affair with an apple, but with different results."

"Your first duty is always to that which lies across your path. The only step which you can take in advance is the next one. This leads to a simplicity of action which is commendable. Don't ramble."

"Cultivate singleness of purpose. This is more important than you may think. It is intuitive with the comparatively ignorant, and often absent in the highly trained. We are frequently surprised at the great competency of the ignorant contractor or foreman, on whom judgment is often passed by saying that he is a practical man and gets results. Analysis will show that his best quality is singleness of purpose, which leads him to vigorously do the one thing before him, without distraction following from knowing or thinking about too many other things."

"When you are getting what you go after, get it all. Avoid the mediocrity of compromise. Be thorough and stand for full competency in everything, from main essentials to details."

"Much of our engineering is only done once, and it must be done right that once. A man who has learned by experience to do a thing deserves no credit for doing it right. He is then only a repeating machine. Real power is characterized by ability to perform right the first time that which a man never did before. Such performance involves the power to assimilate and adapt experiences, of more or less like or unlike kind, in a way to bring forth correct results. This is the true use of experience, wherein a man is a thinking, active power, and not a mere repeater."

"A point of view is involved in the power to rationalize. This is a thing which each man does for himself in his own best way, and its essence consists in asking one's self whether the thing is reasonable. It is a great check upon error. It is the power of the human mind, after performing in more or less systematic and conventional ways, to stand off and look at results and ask one's self whether they are reasonable. One man will figure that certain material weighs two hundred tons, and believe it. Another will say that there is something wrong in that, for it all came on two freight cars."

"It is well for a young engineer to cultivate his vocabulary, and learn to use words in their right sense. They are then usually understood, even by those who have less knowledge. * * * * * Engineering documents, specifications and letters are full of misstatements due to the careless use of language. Conciseness cannot be overestimated. Brevity is desirable, but not at the expense of clearness. Conversely, a certain degree of facility should be acquired in reading the words of others."

"One of the worst attributes in engineering, and which is fundamentally born of conceit, tends to fasten error, censure and responsibility on others. There are times when a man needs to stand himself up in front of himself and ask: 'What is the matter with me?' The capacity of any man to admit his own error and frailty of judgment is a measure of strength rather than weakness."

"When you start your practical work, you will doubtless try to improve things. That is a legitimate purpose, if not overworked. I am not going to attempt to tell you what needs improvement, but the one improvement that most things need is in the line of sufficiency. You can think this over for yourself and apply it where it fits."

"Remember, that all the good you accomplish is going to come out of yourself. You cannot borrow it and you cannot make it out of that which has been poured into you by education or otherwise. All that you receive is only a certain quantity of knowledge, acquired by education, experience or other training, which will have a certain influence upon what comes out of yourself as your own. It is the inherent capacity to perform with your own brain which will make you what you become, and not the mere transmission of that which you have acquired. * * * * * Some have gone through experience without acquiring it, and many a man who has received an education has not got any because he allowed it to be a thing apart from his personality, and it slipped away."

The address, which is entitled "The Point of View," has been reprinted in pamphlet form, and young engineers who are fortunate enough to be in a position to obtain a copy should by all means do so.

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Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

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The American Electrician has a larger paid subscription list than any other electrical journal in the world.

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Successful Central Station Men.

On another page of this number we print the first of a series of biographical sketches of men who have been notably successful in central station development, the subject of this first biography being Mr. John W. Lieb, Jr., the well-known assistant general manager of the New York Edison Company. It may be well to state just here that these biographical articles will be found quite different from the merely complimentary sketches so frequently printed as biographies. The chief object in publishing these articles is to familiarize our readers in general with the actual careers of the men who form the subjects of them and in particular with the factors which have entered most largely into the success of those men; not to indulge in mere laudatory phrasing, which, we feel sure, not only would be little appreciated by our readers but would be offensive to those who have kindly consented to the publication of the facts concerning themselves.

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Electro-Pneumatic Control Apparatus.

The combination of electromagnetic and pneumatic mechanism for operating switches and other apparatus controlled from a distance and requiring considerable power for the operation is an alluring one. It has been employed with conspicuous success in a few instances, such as the control of railway motors and of smaller machinery, where compressed air was necessarily at hand for other purposes, but so far as we know no one has been bold enough to put into commercial use an electro-pneumatic control system where the air-compressor, tank, etc., would be otherwise unnecessary. There are several classes of work in which such a control system appears to be applicable to advantage, such as heavy duty hoists, freight elevators, relay-operated switchboards, etc.

In the case of motor control, with the exception of railway motors, the most convenient arrangement would seem to be the driving of the air-compressor directly by the controlled motor. The control apparatus being naturally located upon or very near the controlled motor, this arrangement would result in the maximum concentration of the involved mechanism, and the use of air-driven pistons for operating the various switches obviously would reduce the electromagnetic mechanisms to small magnets opening and closing balanced pneumatic valves; it would, moreover, greatly reduce the space occupied by the control apparatus and the vulnerability of it. Those familiar with the subject know that an electromagnet capable of exerting considerable power through a range of an inch or two is a ponderous, clumsy affair and liable to be disabled by the most trivial accident. On the contrary, pneumatic cylinders and pistons of great power occupy relatively small space and can be made extremely rugged within that small space; and the magnets to actuate the valves can, because of their smallness, be made very reliable by the use of extra insulation, wires of substantial size, and moderate dead resistances in series with them to reduce the inductive discharge due to opening the circuit.

The case of switchboard operation might or might not be one in which facilities for compressing and storing air would be otherwise unnecessary; in stations equipped with a compressor and system of pipes for cleaning purposes, it obviously would not. Where such compressed air equipments are not in use, it would in all probability be profitable to put in pneumatic apparatus for both cleaning purposes and for actuating high-tension or other heavy-duty switches. The many advantages obtainable by the use of pneumatically operated switches on the main boards, controlled electrically from the attendant's bench, will be apparent to all switchboard construction engineers.

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Balancing a Three-Wire System.

There are in commercial use at least two methods of balancing a three-wire, direct-current system supplied from generators of the over-all voltage of the system; one is to provide a motor-balancer consisting of two machines exactly alike connected in series and rigidly coupled together, the extreme terminals of the pair being connected to the outside conductors of the system and the junction between the machines being connected to the neutral conductor; the other is to provide two auto-transformers for each generator, the terminals of each being tapped into the armature winding at points between which maximum difference of potential occurs periodically, the points of connection for one transformer lying half-way between the points to which the other transformer is connected. This latter arrangement changes an ordinary generator into what is popularly termed a "three-wire" machine. The neutral conductor of the system is connected to the middle point of each auto-transformer. There is a third method which is practical under some conditions of operation; that is to connect a battery of storage cells between the outside wires of the system and connect the neutral conductor to the middle point of the battery.

It is impossible to lay down any general rule as to the choice between the three methods of balancing indicated above, but it may be of interest to consider the practical features of each of them. The motor-balancer presents the very considerable advantage of necessitating only two balancing sets for an entire station, one active and the other alternative. It also has the advantage that it can be compounded to compensate for the drop in the neutral conductors to the system. It has, however, the disadvantage of adding to the machinery of the station, requiring at least some care and attention. The more reliable it is, the less attention will it receive, and when any abnormal condition does arise it is very likely to go unnoticed until the balancer either breaks down or reaches a state necessitating immediate and expensive repairs. If it is not reliable enough to incur this risk, it will require so much attention as to be a nuisance and probably a source of excessive expense. It is entirely too much to expect that a motor-balancer can be so constructed as to require just enough attention to escape both of these extremes.

The auto-transformer "attachment" of a three-wire generator possesses the immense advantage of being inert mechanically. It has the additional advantage of occupying such a small space, relatively, as to make it possible to insulate its conductors beyond the remotest probability of puncture from ordinary causes. Where only one generator is in use, the auto-transformer has the advantage of low first cost; in all cases it has the advantage of low maintenance cost. It entails the disadvantage of a divided series winding on the generator in order to "compound" for an increase in the load on either side of the neutral. Where several generators are operated in parallel, this arrangement of series windings complicates the equalizing connections. There is also the slight drawback that the generator cannot be made to compound accurately for increases in the load on each side of the neutral and also for increases of equal value on both sides simultaneously, because of the drop in the neutral conductors when the load is unbalanced. Then there is the expense of providing an auto-transformer for each governor instead of being able to use a single balancing apparatus for the whole plant, as in the case of the motor-balancer.

The storage battery balancer has conspicuous operating advantages; used in connection with a suitable booster, it can be made to balance the system perfectly for any changes of load, without the use of series windings on the generators, and also to take the peak of the load and thereby reduce the amount of generator capacity required. Without the booster it is capable of balancing the system practically as well as the auto-transformer and, of course, of taking the load peak; under most conditions, however, storage battery operation without a booster can scarcely be considered satisfactory. A battery balancer is heavily handicapped by the enormous space it occupies and by the constant and highly skilled attention demanded by it in order to obtain reasonably efficient results. The expense of installation, also, is out of all proportion to that of either of the other types mentioned, and it adds to its own disadvantages those of the motor-balancer by requiring a booster. Except in stations where it would pay to instal a battery as an auxiliary regardless of balancing the distribution system, it is practically certain that a battery balancer cannot compete with either the motor or the auto-transformer.

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Magnet Windings.

At least once before, and possibly more than once, we have pointed out the fact that the theory advanced in most text books to the effect that the convolutions of each layer of a magnet coil "bed" in the creases formed between adjacent convolutions of the preceding layer cannot possibly be true of coils wound in the ordinary continuous manner. From the receipt of numerous inquiries as to the allowance that should be made for this imaginary bedding we judge that the previous explanations of the matter have not reached all of our present readers; hence the following remarks.

Unless all the layers of a magnet coil start from the same end of the coil, which is manifestly impracticable, the crease between adjacent convolutions, due to the convexity of that part of each that is left exposed, is necessarily a right-handed spiral in one layer, a left-handed spiral in the next layer, and so on. It is obvious that concentric right-handed and left-handed spirals cannot mesh or bed with each other any better than the threads of a right-handed nut can mesh with those of a left-handed screw. Consequently, no allowance should be made for the bedding of magnet coil convolutions. However, the thickness of a given number of layers will be slightly less than the width of the same number of convolutions side by side, no matter how closely the successive convolutions may be wound. The reason for this is that the tension put on the wire in the process of winding compresses that part of the insulation on the wire which separates the wires of contiguous layers and draws the successive layers into much more intimate contact than that between the adjacent convolutions of a layer. An allowance of 2 per cent for the compression of insulation is ample in the case of double cotton covered wires of ordinary sizes—say No. 8 to No. 20, B. & S. gauge.

A feature of constant-potential magnet windings which also is not always grasped by the student is that the magnetizing power of a coil depends upon the average length of one turn, the voltage at the terminals and the size of the wire. Within practical limits the length of the coil parallel with the magnet core has no influence over its magnetizing power so long as the terminal voltage is unchanged. The coil length determines the amount of current required to produce a given magnetic effect and also the extent of the heating of the coil, the size of the wire having been determined. On the other hand, the magnetizing effect of a coil supplied with a certain fixed current depends only on the strength of that current and the number of turns in the coil. The size of the wire in the coil and the average length per turn have no influence on the magnetic results, but they determine the voltage at the terminals of the winding and, consequently, the number of watts expended and the heating produced, the number of turns being fixed.

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Electricity in Mining.

From expressions of opinion recently given out independently by several experienced engineers it would appear that the application of electricity to mining operations has not been carried to anything like the extent that the possibilities of the field would justify. We confess considerable surprise at finding this opinion held by the men who have expressed it. There is certainly no lack of enterprise in this direction by American manufacturers; one can buy highly developed electrical apparatus for performing every mining operation that can be economically performed by machinery of any kind. If such apparatus is not used in every place where is could be applied to advantage, it would seem that some vigorous educational work among mine superintendents might be done profitably.

DESIGN AND CONSTRUCTION OF SMALL DYNAMOS AND MOTORS.

BY CECIL P. POOLE.

In the previous article we found, in "roughing-out" a 5-h.p., 220-volt motor to run at 1000 r.p.m., that a polar bore of 8 ins. was sufficient according to the preliminary formula, but that the required number of wires could not be got into that diameter. In such a case, the proper procedure is as follows:

Ascertain how many slots the armature core will take without violating Rule V; this will enable one to ascertain the maximum number of wires than can be put on the core. Then, by means of formula 3, find out what the armature speed would be with this number of wires. Multiply this speed by the "corrective constant" opposite the polar bore in Table II; divide the product by the speed at which the armature should run. The result will be the corrective constant corresponding to the proper diameter of polar bore to be used. Applying this method to the case in hand: If we make the total tooth widths equal to the polar bore (8 ins.), this will leave 8.49 ins. of the tooth-root circle (see Fig. 3) available for slots, and as the slot for No. 13 wire is 0.21 in. wide, we can get in 8.49 ÷ 0.21 = practically 40 slots. These will hold 480 wires, and according to formula 3, the speed would be

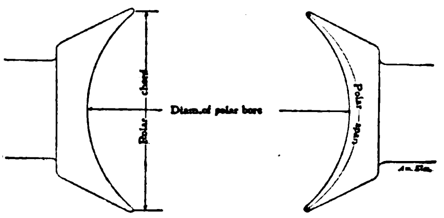

FIG. 1.

$$\frac{1000 \times 220}{0.2325 \times 480} = 1948.7 \text{ r.p.m.}$$

The "corrective constant" corresponding to 8 in. polar bore is 699.4, and this multiplied by 1948.7 = 1,362,900. Dividing this product by the desired speed of 1000 r.p.m. gives 1362.9 as the corrective constant for the proper diameter; reference to column 8 of Table II (second section) shows that 1362.9 falls between 1358 and 1413; consequently, the proper diameter of polar bore will be between 9⅞ and 10 inches. The smaller value may be taken, because 1362.9 is much nearer to 1358 than to 1413.

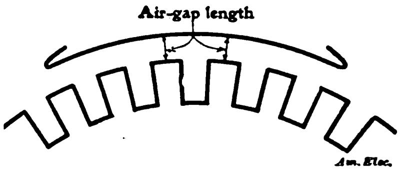

FIG. 2.

Preliminary Formulas:

K_p = Armature watts ÷ r.p.m. (1)

E.m.f. = K_e × wires × r.p.m. ÷ 1000 .... (2)

R.p.m. = 1000 × e.m.f. ÷ K_e × wires (3)

K_e = Constant for voltage corresponding to a given diameter of polar bore (See Table II.)

K_p = Constant for power corresponding to a given diameter of polar bore (See Table II).

The diameter of the polar bore being 9⅞ in., the air-gap, according to Table III, will

TABLE I.—Armature Current and Watts.

H.P.	Motor Armature watts.	Motor Armature Current per wire at Different Voltages. 110 V.	220 V.	250 V.	500 V.
¼	310	1.8	0.9	0.62	0.31
½	572	2.6	1.3	1.15	0.57
¾	790	3.6	1.8	1.58	0.79
1	990	4.5	2.25	2.	0.99
1½	1430	6.5	3.25	2.86	1.43
2	1870	8.5	4.25	3.74	1.87
3	2730	12.4	6.2	5.46	2.73
4	3575	16.25	8.13	7.15	3.58
5	4400	20.	10.	8.8	4.4
6	5215	23.7	11.85	10.43	5.22
8	6860	31.	15.5	13.72	6.86
10	8360	38.	19.	16.72	8.36
12½	10340	47.	23.5	20.7	10.34
15	12540	114 ÷ p*	28.5	25.1	12.54
20	16500	150 ÷ p*	37.5	33.	16.5

*p = number of field magnet poles.

In 110-volt dynamos of more than 10 kilowatts, the current per armature wire is the delivered current multiplied by 1.05 and divided by the number of field magnet poles.

In all other dynamos, the current per wire is the delivered current multiplied by 0.55.

TABLE VI.—Maximum Safe Number of Turns per Armature Coil.

Amperes per armature wire. Lap Winding.	Two-path Windings. 4 Poles.	6 Poles.	Maximum turns per coil.
56.25	42.2	28.125	2
25	18.75	12.5	3
14	10.5	7.	4
9	6.75	4.5	5
6.25	4.7	3.125	6
4.6	3.45	2.3	7
3.5	2.62	1.75	8
2.8	2.1	1.4	9
2.25	1.68	1.12	10
1.86	1.4	0.93	11
1.56	1.17	0.78	12
1.33	1.	0.67	13
1.15	....	....	14
1.	....	....	15
0.88	....	....	16
0.78	....	....	17
0.69	....	....	18
0.62	....	....	19
0.56	....	....	20
0.51	....	....	21
0.46	....	....	22
0.42	....	....	23
0.39	....	....	24
0.36	....	....	25
0.333	....	....	26
0.31	....	....	27

When the actual current per armature wire falls between two of the numbers in the proper column of the table, take the number of turns corresponding to the greater of the two numbers between which the actual current lies.

TABLE IV.—Current-carrying Capacity of Round Armature Wires. B. & S. Gauge.

Wire size.	At Table III speeds.	At lower speeds.
8	40	34
9	32	27
10	25.6	21.7
11	20	17
12	16	13.6
13	12.8	10.9
14	10	8.5
15	8	6.8
16	6.5	5.5
17	5.1	4.3
18	4.1	3.5
19	3.3	2.8
20	2.6	2.2
21	2.1	1.78
22	1.7	1.45
23	1.35	1.15
24	1.1	0.93
25	0.9	0.76
26	0.7	0.59
27	0.56	0.47
28	0.46	0.39
29	0.36	0.31
30	0.29	0.25

TABLE III.—Continued.—General Data.

Diam. Polar Bore.	Air-Gap. 4 Poles.	6 Poles.	Ampere-Wires. 4 Poles.	6 Poles.	R. P. M.
8	3/32	1/16	8196	8196	1345
8 1/8	3/32	1/16	8214	8214	1330
8 1/4	7/64	5/64	9600	10,290	1315
8 3/8	7/64	5/64	9624	10,312	1300
8 1/2	7/64	5/64	9646	10,334	1285
8 5/8	7/64	5/64	9666	10,356	1270
8 3/4	7/64	5/64	9688	10,380	1255
8 7/8	7/64	5/64	9708	10,402	1240
9	1/8	5/64	11,120	10,424	1225
9 1/8	1/8	5/64	11,140	10,446	1215
9 1/4	1/8	5/64	11,164	10,470	1205
9 3/8	1/8	5/64	11,190	10,492	1195
9 1/2	1/8	3/32	11,216	12,610	1185
9 5/8	1/8	3/32	11,236	12,634	1175
9 3/4	1/8	3/32	11,256	12,660	1165
9 7/8	1/8	3/32	11,276	12,684	1150
10	1/8	3/32	11,296	12,708	1140
10 1/8	1/8	3/32	11,320	12,735	1130
10 1/4	1/8	3/32	11,344	12,762	1120
10 3/8	1/8	3/32	11,364	12,786	1110
10 1/2	9/64	3/32	12,800	12,806	1100
10 5/8	9/64	3/32	12,826	12,826	1090
10 3/4	9/64	3/32	12,850	12,850	1080
10 7/8	9/64	3/32	12,874	12,874	1070
11	9/64	3/32	12,896	12,896	1060
11 1/8	9/64	3/32	12,918	12,918	1050
11 1/4	9/64	3/32	12,942	12,942	1040
11 3/8	9/64	3/32	12,966	12,966	1030
11 1/2	9/64	3/32	12,986	12,986	1020
11 5/8	9/64	3/32	13,004	13,004	1010
11 3/4	9/64	3/32	13,024	13,024	1000
11 7/8	9/64	3/32	13,042	13,042	990
12	5/32	7/64	14,510	15,246	980
12 1/8	5/32	7/64	14,530	15,266	970
12 1/4	5/32	7/64	14,554	15,288	960
12 3/8	5/32	7/64	14,584	15,310	950
12 1/2	5/32	7/64	14,610	15,340	940
12 5/8	5/32	7/64	14,630	15,360	935
12 3/4	5/32	7/64	14,650	15,382	930
12 7/8	5/32	7/64	14,670	15,402	925
13	11/64	7/64	16,158	15,424	920
13 1/8	11/64	7/64	16,180	15,444	915
13 1/4	11/64	7/64	16,202	15,466	910
13 3/8	11/64	7/64	16,226	15,492	905
13 1/2	11/64	7/64	16,258	15,518	900
13 5/8	11/64	7/64	16,280	15,540	895
13 3/4	11/64	7/64	16,300	15,560	890
13 7/8	11/64	7/64	16,324	15,582	885
14	3/16	1/8	17,832	17,832	880
14 1/8	3/16	1/8	17,856	17,856	875
14 1/4	3/16	1/8	17,880	17,880	870
14 3/8	3/16	1/8	17,904	17,904	865
14 1/2	3/16	1/8	17,928	17,928	860
14 5/8	3/16	1/8	17,946	17,946	855
14 3/4	3/16	1/8	17,964	17,964	850
14 7/8	3/16	1/8	17,988	17,988	845
15	3/16	1/8	18,012	18,012	840
15 1/8	3/16	1/8	18,036	18,036	835
15 1/4	3/16	1/8	18,060	18,060	830
15 3/8	3/16	1/8	18,084	18,084	825
15 1/2	3/16	1/8	18,108	18,108	820
15 5/8	3/16	1/8	18,126	18,126	815
15 3/4	3/16	1/8	18,144	18,144	810
15 7/8	3/16	1/8	18,168	18,168	800
16	3/16	1/8	18,192	18,192	805

TABLE II.—Armature Diameter Constants.

Diam. Polar Bore.	K_p Constant for Power.		K_e Constant for Voltage.			K_e Corrective Constant	Diam. Polar Bore.
	2 Poles.	4 Poles.	2 Poles.	Four Poles. Wave.	Four Poles. Lap.		
3	0.3363	....	0.0486	....	....	31.84	3
3 1/16	3608	....	0508	....	....	33.97	3 1/16
3 1/8	3780	....	0531	....	....	36.21	3 1/8
3 3/16	4046	....	0554	....	....	38.54	3 3/16
3 1/4	0.4325	....	0.0578	....	....	40.97	3 1/4
3 5/16	4617	....	0602	....	....	43.50	3 5/16
3 3/8	4922	....	0627	....	....	46.14	3 3/8
3 7/16	5241	....	0652	....	....	48.88	3 7/16
3 1/2	0.5574	....	0.0678	....	....	51.74	3 1/2
3 9/16	5901	....	0704	....	....	54.71	3 9/16
3 5/8	6285	....	0731	....	....	57.79	3 5/8
3 11/16	6663	....	0758	....	....	60.98	3 11/16
3 3/4	0.7040	....	0.0786	....	....	64.45	3 3/4
3 13/16	7329	....	0814	....	....	67.74	3 13/16
3 7/8	7750	....	0843	....	....	71.29	3 7/8
3 15/16	8186	....	0873	....	....	74.98	3 15/16
4	0.8640	....	0.0903	....	....	78.79	4
4 1/8	0.9598	....	0965	....	....	86.81	4 1/8
4 1/4	1.0456	....	1029	....	....	95.37	4 1/4
4 3/8	1.1548	....	1095	....	....	104.5	4 3/8
4 1/2	1.2719	....	0.1164	....	....	114.19	4 1/2
4 5/8	1.3970	....	1234	....	....	124.48	4 5/8
4 3/4	1.5303	....	1307	....	....	135.39	4 3/4
4 7/8	1.6484	....	1382	....	....	146.93	4 7/8
	1.7979	1.063	0.1459	0.0856	0.0428	159.13	5
5 1/8	1.957	1.152	1539	0902	0451	172.	5 1/8
5 1/4	2.125	1.246	1621	0950	0475	185.57	5 1/4
5 3/8	2.303	1.346	1705	1000	0500	199.85	5 3/8
5 1/2	2.491	1.438	0.1791	0.1050	0.0525	214.85	5 1/2
5 5/8	2.656	1.560	1880	1102	0551	230.62	5 5/8
5 3/4	2.864	1.676	1971	1156	0578	247.15	5 3/4
5 7/8	3.045	1.798	2064	1211	0606	264.47	5 7/8
6	3273	1.925	0.2159	0.1266	0.0633	282.60	6
6 1/8	....	2.060	....	1324	0662	301.6	6 1/8
6 1/4	....	2.200	....	1383	0692	321.4	6 1/4
6 3/8	....	2.347	....	1443	0722	342.1	6 3/8
6 1/2	....	2.500	....	0.1505	0.0753	363.6	6 1/2
6 5/8	....	2.661	....	1568	0784	386.1	6 5/8
6 3/4	....	2.828	....	1632	0816	409.6	6 3/4
6 7/8	....	3.002	....	1698	0849	433.9	6 7/8
7	....	3.184	....	0.1765	0.0883	459.3	7
7 1/8	....	3.431	....	1833	0917	485.6	7 1/8
7 1/4	....	3.631	....	1903	0952	512.9	7 1/4
7 3/8	....	3.838	....	1974	0987	541.3	7 3/8
7 1/2	....	4.054	....	0.2047	0.1024	570.7	7 1/2
7 5/8	....	4.277	....	2121	1061	601.2	7 5/8
7 3/4	....	4.510	....	2196	1098	632.9	7 3/4
7 7/8	....	4.751	....	2274	1137	665.5	7 7/8

TABLE III.—General Data.

Diam, Polar Bore.	Air-Gap.		Ampere-Wires.		R. P. M.
	2 Poles.	4 Poles.	2 Poles.	4 Poles.	
3	1/16	....	2358	....	2800
3 1/16	1/16	....	2366	....	2760
3 1/8	5/64	....	2964	....	2720
3 3/16	5/64	....	2974	....	2680
3 1/4	5/64	....	2982	....	2640
3 5/16	5/64	....	2992	....	2605
3 3/8	5/64	....	3000	....	2570
3 7/16	5/64	....	3010	....	2535
3 1/2	5/64	....	3016	....	2500
3 9/16	5/64	....	3024	....	2465
3 5/8	5/64	....	3032	....	2435
3 11/16	5/64	....	3040	....	2405
3 3/4	3/32	....	3656	....	2375
3 13/16	3/32	....	3666	....	2345
3 7/8	3/32	....	3674	....	2315
3 15/16	3/32	....	3684	....	2290
4	3/32	....	3692	....	2265
4 1/8	3/32	....	3710	....	2210
4 1/4	3/32	....	3726	....	2160
4 3/8	7/64	....	4368	....	2115
4 1/2	7/64	....	4384	....	2070
4 5/8	7/64	....	4400	....	2030
4 3/4	7/64	....	4420	....	1990
4 7/8	7/64	....	4438	....	1950
	1/8	1/16	5090	5090	1915
5 1/8	1/8	1/16	5110	5110	1880
5 1/4	1/8	1/16	5128	5128	1849
5 3/8	1/8	1/16	5148	5148	1815
5 1/2	1/8	1/16	5164	5164	1785
5 5/8	9/64	1/16	5824	5180	1755
5 3/4	9/64	1/16	5850	5200	1725
5 7/8	9/64	5/64	5868	6500	1695
6	9/64	5/64	5886	6540	1670
6 1/8	....	5/64	....	6560	1645
6 1/4	....	5/64	....	6580	1620
6 3/8	....	5/64	....	6600	1595
6 1/2	....	5/64	....	6620	1570
6 5/8	....	5/64	....	6640	1545
6 3/4	....	5/64	....	6660	1520
6 7/8	....	5/64	....	6674	1500
	....	5/64	....	6694	1480
7 1/8	....	3/32	....	8050	1460
7 1/4	....	3/32	....	8070	1440
7 3/8	....	3/32	....	8090	1420
7 1/2	....	3/32	....	8118	1405
7 5/8	....	3/32	....	8136	1390
7 3/4	....	3/32	....	8154	1375
7 7/8	....	3/32	....	8178	1360

TABLE II, Continued.—Armature Diameter Constants

Diam. Polar Bore.	K_p Constant for Power.		K_e Constant for Voltage.				K_e Corrective Constant.	Diam. Polar Bore.
	4 Poles.	6 Poles.	4 Poles. Wave.	4 Poles. Lap.	6 Poles. Wave.	6 Poles. Lap.		
8	5.001	3.433	0.2352	0.1176	0.1613	0.0537	699.4	8
8 1/8	5.257	3.633	2431	1216	1668	0556	734.4	8 1/8
8 1/4	5.530	3.767	2513	1257	1723	0575	770.6	8 1/4
8 3/8	5.804	3.98	2595	1298	1780	0593	808	8 3/8
8 1/2	6.092	4.205	0.2679	0.134	0.1837	0.612	846.6	8 1/2
8 5/8	6.287	4.279	2764	1382	1896	0632	886.4	8 5/8
8 3/4	6.695	4.586	2851	1426	1956	0652	927.5	8 3/4
8 7/8	7.014	4.834	2942	1471	2018	0673	969.9	8 7/8
9	7.338	5.088	0.3029	0.1515	0.2078	0.0693	1,013	9
9 1/8	7.694	5.264	3120	1560	2140	0713	1,059	9 1/8
9 1/4	8.028	5.526	3213	1607	2203	0754	1,105	9 1/4
9 3/8	8.388	5.807	3307	1654	2268	0756	1,153	9 3/8
9 1/2	8.758	5.986	0.3403	0.1702	0.2334	0.0778	1,202	9 1/2
9 5/8	9.138	6.282	3500	1750	2400	0800	1,252	9 5/8
9 3/4	9.645	6.587	3598	1799	2468	0823	1,304	9 3/4
9 7/8	10.055	6.784	3698	1849	2536	0845	1,358	9 7/8
10	10.5	7.125	0.3800	0.1900	0.2606	0.0869	1,413	10
10 1/8	10.887	7.429	3898	1949	2674	0891	1,467	10 1/8
10 1/4	11.352	7.789	4006	2003	2748	0916	1,527	10 1/4
10 3/8	11.808	8.008	4113	2057	2821	0940	1,586	10 3/8
10 1/2	12.278	8.371	0.4220	0.2110	0.2894	0.0956	1,647	10 1/2
10 5/8	12.902	8.744	4329	2165	2969	0990	1,710	10 5/8
10 3/4	13.254	9.131	4439	2220	3044	1015	1,774	10 3/4
10 7/8	13.742	9.378	4551	2276	3121	1040	1,840	10 7/8
11	14.286	9.783	0.4664	0.2332	0.3199	0.1066	1,907	11
11 1/8	14.79	10.182	4774	2387	3274	1091	1,974	11 1/8
11 1/4	15.37	10.627	4895	2448	3357	1119	2,047	11 1/4
11 3/8	15.93	10.9	5012	2506	3438	1146	2,120	11 3/8
11 1/2	16.513	11.352	0.5132	0.2566	0.3520	0.1173	2,194	11 1/2
11 5/8	17.10	11.811	5252	2626	3602	1201	2,270	11 5/8
11 3/4	17.71	12.106	5374	2687	3686	1229	2,348	11 3/4
11 7/8	18.33	12.59	5498	2749	3771	1257	2,427	11 7/8
12	18.97	13.09	0.5622	0.2811	0.3856	0.1285	2,509	12
12 1/8	19.62	13.59	5751	2876	3945	1315	2,592	12 1/8
12 1/4	20.28	13.92	5878	2939	4031	1344	2,677	12 1/4
12 3/8	20.97	14.45	6009	3005	4122	1374	2,764	12 3/8
12 1/2	21.67	15.	0.6138	0.3069	0.4210	0.1403	2,853	12 1/2
12 5/8	22.59	15.35	6273	3137	4302	1434	2,944	12 5/8
12 3/4	23.33	15.92	6408	3204	4395	1465	3,036	12 3/4
12 7/8	24.08	16.50	6542	3271	4487	1496	3,121	12 7/8
13	24.85	17.10	0.6679	0.3340	0.4581	0.1527	3,228	13
13 1/8	25.64	17.48	6819	3410	4677	1559	3,327	13 1/8
13 1/4	26.44	18.10	6959	3480	4773	1591	3,428	13 1/4
13 3/8	27.26	18.74	7102	3551	4871	1624	3,530	13 3/8
13 1/2	28.10	19.15	0.7244	0.3622	0.4968	0.1656	3,635	13 1/2
13 5/8	28.96	19.81	7389	3695	5068	1689	3,743	13 5/8
13 3/4	29.83	20.49	7535	3768	5168	1723	3,852	13 3/4
13 7/8	30.72	21.19	7683	3842	5269	1756	3,963	13 7/8
14	31.64	21.63	0.7833	0.3917	0.5372	0.1791	4,077	14
14 1/8	32.56	22.35	7984	3992	5476	1825	4,192	14 1/8
14 1/4	33.51	23.09	8137	4069	5581	1860	4,310	14 1/4
14 3/8	34.48	23.56	8290	4145	5686	1895	4,431	14 3/8
14 1/2	35.46	24.33	0.8446	0.4223	0.5793	0.1931	4,553	14 1/2
14 5/8	36.47	25.11	8602	4301	5900	1967	4,678	14 5/8
14 3/4	37.51	25.91	8764	4382	6011	2004	4,805	14 3/4
14 7/8	38.54	26.42	8923	4462	6120	2040	4,935	14 7/8
15	39.61	27.25	0.9087	0.4544	0.6232	0.2077	5,066	15
15 1/8	40.69	28.10	9248	4624	6343	2114	5,201	15 1/8
15 1/4	41.81	28.64	9415	4708	6457	2152	5,335	15 1/4
15 3/8	43.27	29.51	9582	4791	6572	2191	5,476	15 3/8
15 1/2	44.42	30.41	0.9748	0.4874	0.6686	0.2229	5,618	15 1/2
15 5/8	45.60	31.33	0.9918	4959	6802	2267	5,762	15 5/8
15 3/4	46.80	31.91	1.009	5045	6921	2307	5,908	15 3/4
15 7/8	48.02	32.85	1.0262	5131	7039	2346	6,057	15 7/8
16	49.26	33.82	1.0437	5219	7158	2386	6,208	16

be ⅛ in.; consequently the armature core will be 9⅝ in. diameter over the teeth. With this air-gap, the coil slots could be made 0.29 in. wide without violating Rule II, and thus two wires could be put side by side in a slot instead of singly, as previously. This will allow still further readjustment of the diameter and enable the latter to be reduced somewhat. Slots 0.29 by 1 5-32 in. will take 2 × 12 = 24 No. 13 wires each. The diameter of the circle at the tooth roots will be 9⅝ — 2 5-16 = 7 5-16 in.; the circumference of this circle is 22.97 in.; the sum of the tooth-root widths must equal the polar bore (9⅞ ins.) and this will leave 22.97 — 9.875 = 13.1 in. for the sum of the slot widths. The maximum allowable number of slots, therefore, will be 13.1 ÷ 0.29 = 45. There are 24 wires per slot, so that the total number of wires will be 45 × 24 = 1080. According to formula 3, the speed would be

$$\frac{1000 \times 220}{0.3698 \times 1080} = 550.85 \text{ r.p.m.}$$

Multiplying this by the corrective constant for 9⅞ in. diameter, we get 550.85 × 1,358 = 748,054; dividing this by the desired speed of 1000, we have 748 as the corrective constant for the desired polar bore; Table II (second section) shows that the corre-

TABLE V.—Slot Dimensions for Standard Sizes of Round Armature Wires, Double Cotton Insulation.

Wire sizes.	Slot width. No. of wires side by side. 1	2	3	4	5	Wire sizes.	Slot depth. Total number of wires, depthwise of slot: 4	6	8	10	12	14	16	18	20	Wire sizes.
8	.27	..	..	..	..	8	3/4	1 1/32	1 5/16							8
9	.25	..	..	..	..	9	11/16	15/16	1 3/16							9
10	.24	.35	..	..	..	10	5/8	7/8	1 1/16							10
11	.23	.33	..	..	..	11	19/32	25/32	1							11
12	.22	.31	..	..	..	12	9/16	3/4	15/16	1 3/32	1 9/32					12
13	.21	.29	.37	..	..	13	1/2	11/16	27/32	1	1 5/32					13
14	.20	.28	.35	..	..	14	...	5/8	25/32	15/16	1 1/16	1 7/32	1 3/8	1 1/2		14
15	..	.26	.33	..	..	15	...	9/16	11/16	27/32	1	1 1/8	1 1/4	1 3/8	1 1/2	15
16	..	.25	.31	.37	..	16	...	...	21/32	25/32	29/32	1 1/32	1 3/16	1 5/16	1 7/16	16
17	..	.24	.29	.34	..	17	...	...	5/8	23/32	27/32	15/16	1 1/16	1 3/16	1 1/4	17
18	..	.23	.28	.33	..	18	...	...	9/16	11/16	25/32	7/8	31/32	1 1/16	1 3/16	18
19	..	.22	.26	.31	..	19	...	...	...	5/8	23/32	13/16	29/32	1	1 1/16	19
20	..	.21	.25	.29	.33	20	...	...	...	19/32	21/32	3/4	27/32	15/16	1	20
21	..	.20	.24	.28	.31	21	...	...	...	9/16	5/8	23/32	25/32	7/8	15/16	21
22	..	..	.23	.26	.30	22	...	...	...	17/32	19/32	21/32	3/4	13/16	7/8	22

Instructions for "Laying-out" the Armature.

A.—Find the value of Kp by formula 1. Find the corresponding polar bore in Table II; jot it down.

B.—Find the proper air-gap in Table III. Deduct twice the air-gap from the bore to get the armature diameter; jot it down. Multiply the air-gap by 3 to get the maximum allowable slot width.

C.—Find the current per wire from Table I and note it. From Table IV find the estimated size of wire to carry the current; note it. From the left-hand section of Table V find the widest slot (for the wire) that will not exceed 3 times the air-gap; note it. Then from the right-hand section select the deepest slot (for the wire) that does not exceed 6 times the width just found; note it.

D.—From the armature diameter subtract twice the slot depth to get the tooth-root circle; find the circumference of the circle and note it. From this circumference subtract the diameter of the polar bore; divide the remainder by the width of the coil slot to get the number of slots allowable, discarding the fraction in the result if it is less than ⅔, and taking the next larger number if the fraction is ⅔ or over. Note the number of slots.

E.—Multiply the number of slots by the wires per slot to get total wires. Apply formula 2 (for a dynamo) or formula 3 (for a motor) to see if the armature will give the desired result. If not, revise the diameter according to the method described under Preliminary Correction.

F.—After correcting, follow out Instructions B, D and E, checking the new proportions by Rules II, III and IV as you go along.

G.—After obtaining a diameter which gives the desired e.m.f. or speed make sure that the total number of wires × amperes per wire does not exceed the limit prescribed in columns 4 and 5 of Table III.

H.—If the ampere-wires should be too great, make the slots one size shallower and apply Instructions D, E, F and G.

Rules.

Rule I.—The armature of a 110-volt dynamo of more than 10 kilowatts or a 110-volt motor of more than 12½ horse-power must be lap-wound, with as many paths through the winding as there are poles on the field magnet. All other machines are to have two-path wave-connected armature windings.

Rule II.—The width of an armature coil slot must not exceed three times the length of the air-gap; if possible, it should be kept within twice the air-gap length.

Rule III.—The depth of a coil slot must not exceed six times its width; if possible, it should be kept within four times its width.

Rule IV.—The air-gap length must not be less than the value given in Table III opposite the diameter of polar bore and under the proper number of magnet poles.

Rule V.—The sum of the widths of all the armature teeth, measured at the narrowest part, must be practically equal to the diameter of the polar bore.

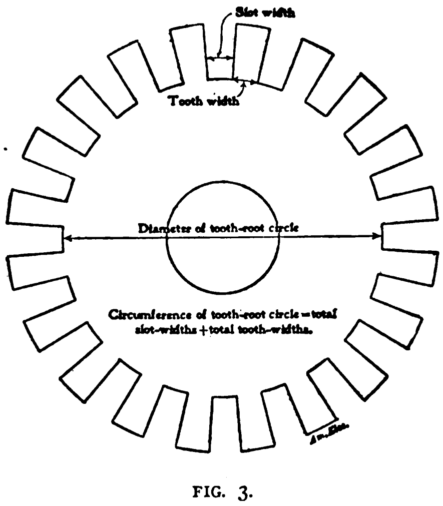
Slot width
Tooth width
Diameter of tooth-root circle
Circumference of tooth-root circle = total slot-widths + total tooth-widths.

FIG. 3.

The sides of each slot in the engraving should be parallel instead of radial.

Preliminary Corrections.

Dynamos.—Having obtained a trial polar bore diameter which does not give the desired e.m.f., multiply the desired e.m.f. by the corrective constant corresponding to the trial polar bore and divide the product by the e.m.f. obtainable with the trial bore. The result will be the corrective constant corresponding to the polar bore which will give the desired e.m.f. when Instruction D has been followed without changing the number of wires per slot or the size of the slot.

If retaining the same size of slot violates Rule II, a narrower slot must be substituted and Instructions D and E applied.

If the new polar bore entails an increase in the air-gap sufficient to allow the use of the next wider slot size in Table V, substitute that slot width and apply Instructions D and E.

Motors.—Having obtained a trial polar bore diameter which does not give the desired speed, multiply the speed that it does give by the corrective constant corresponding to the trial bore and divide the product by the desired speed. The result will be the corrective constant corresponding to the polar bore diameter, which will give the desired speed when Instruction D has been followed without changing the number of wires per slot or the size of the slot. If retaining the same size of slot violates Rule II, a narrower slot must be substituted and Instructions D and E applied.

If the new polar bore entails an increase in the air-gap sufficient to allow the use of the next wider slot size in Table V, substitute that slot width and apply Instructions D and E.

sponding bore is between 8⅛ and 8¼ in. Taking the larger diameter, the air-gap (Table III) will be 7-64 in., and the slot width still comes within the limit prescribed by Rule II.

The next step is to see whether or not the number of ampere-wires comes within the limit set by Table III. The armature core diameter is equal to the polar bore minus twice the air-gap, of course, and 8¼ — 7-32 = 8 1-32 in. The tooth-root circle will be 8 1-32 — 2 5-16 = 5 23-32 in. in diameter; its circumference will be 17.966 in. The tooth roots must be 8¼ in., leaving for the slots 9.71 in.; 9.7 ÷ 0.29 = 33.448, so that 33 slots can be used. This means 33 × 24 = 792 wires total, and the current per wire being 10 amperes (Table I), the ampere-wires will be 7920. The maximum allowable number is 9600 (column 4, Table III), so that we are within the limit by a very safe margin.

The next step is to check the speed. By formula 3, it will be

$$\frac{220{,}000}{0.2513 \times 792} = 1105 \text{ r.p.m.}$$

and if this is undesirably high it can be corrected by increasing the diameter of the armature one point and thereby increasing the number of wires and the factors which are contained in the "constant" K.

The correction of the preliminary diameter of a dynamo polar bore is made in a similar manner. After finding roughly the approximate diameter by means of formula 1, ascertain the size and number of slots, and from these the number of wires; then try the results for e.m.f. by formula 2. If the e.m.f. is not what was intended, find the corrective constant of the polar bore thus far determined; multiply it by the desired e.m.f.; divide the product by the e.m.f. that the armature will give, and the result will be the corrective constant of the polar bore that must be used instead of the one first ascertained.

In order to enable a beginner to grasp the method of "laying-out" more easily, the procedure already described is summed up in the accompanying code of instructions. For still further simplifying the method, formula 1 has been substituted for formulas 1-a and 1-b of the preceding article, and Tables II and III have been made to eliminate Table III of that article. Table VI is new this month, and should be consulted as a guide to the proper number of turns per armature coil. The limits in the table are not rigid, but they should not be exceeded when it can be avoided. It should not be forgotten that the speed values in Table III are merely suggested as appropriate for fairly high-speed armatures; the method of design on which these articles are based is not dependent on the speeds in the table.

◆

Simple Polarity Indicator.—A very simple and efficient polarity indicator may be made from white blotting paper saturated with a solution of potassium iodide. When a test is to be made the paper is moistened and the leads pressed down upon it about a half-inch apart. The positive end will turn brown, while the negative will not be affected.

SOME HINTS ON CONDUIT WORK.

BY T. F. M'MACKIN.

The use of conduits or iron pipes is the favorite method of concealing wires for all purposes in newly erected edifices. Although this system has many advantages over the old methods employed, especially those involving the use of mouldings and porcelain cleats, it presents many difficulties not easily overcome. These difficulties are met with chiefly in overhauling old buildings, or in fire-proof construction in warehouses, power houses, etc. In running circuits on the ceilings of a warehouse or storage plant, extra strong beams are often encountered. These run the entire length of the floor and are supported by 12-in. x 12-in wooden pillars placed equal distances apart to increase the holding capacity of the floor. In passing under these beams a saddle bend is required, as shown in Fig. 1. Fig. 2 illustrates a badly-made saddle which is often used; it is of poor workmanship and is dangerous in floors having a low ceiling. Saddle bends on pipes under the floors are easy to make. Wherever the pipe crosses a beam it is pounded with a heavy plank or joist until it conforms to the shape of the beam, using one's feet to steady same during the operation. Saddles required on the ceiling are bent first according to measurement and then installed. The best method is to place a size larger coupling between the jaws of a double-V vise.

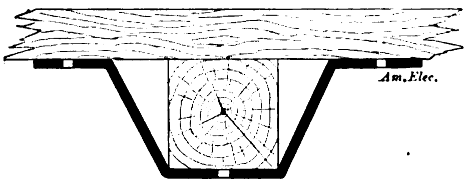

FIG. 1.

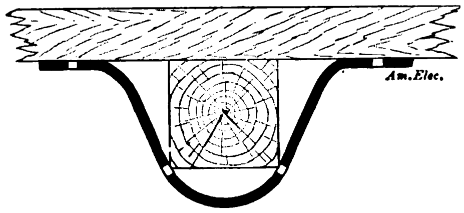

FIG. 2.

The trouble met with in fire-proof buildings lies in the question of hangers or fasteners; there is no woodwork to fasten the pipes to, but a number of wrought-iron I-beams are available. Special wrought-iron hangers can be made, suitable for almost any conditions. This scheme has been applied to several power houses in this city with good results. Fig. 3 shows a sketch of several circuits in ½-in. pipe conduits carried across the ceiling from the switch box to their respective outlets. Each of these circuits, twelve in number, comprises two No. 14 B. & S. wires and the conduits are held by hangers attached to the wrought-iron I-beams. The hanger is made of strap wrought iron ¼ inch thick and 1¼ inch wide and is in two parts, the top and bottom. Each part consists of a bar 10 inches long, having a hole ⅛ inch in diameter at each end and one in the center; ⅛-in. bolts and nuts serve to hold the parts together. The top bar has two extra holes at the center to hold small wrought-iron lugs which grasp the I-beam, as shown in Fig. 3*a*. The top bar is put up first, then the pipe and the bottom bar.

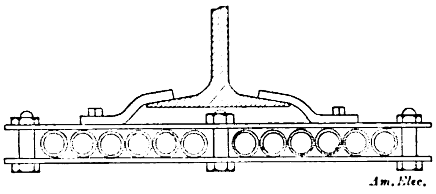

FIG. 3.

Figs. 4 to 12 represent band iron hangers used in the same power house and a scheme for holding a conduit box. The band iron is ⅛ inch thick and 1 inch wide and is serviceable for all small sizes of conduit. In the majority of cases the I-beam is dug out on both sides to admit the lugs of the hanger. In Fig. 4 is shown the hanger most commonly used, consisting of a small piece of band iron 5 inches long. It has a hook bend on each end and is secured in place by hammering both ends over the edge of the I-beam. There are three forms of this hanger, one to accommodate a single pipe irregular in form, one to accommodate three pipes and another to take four pipes. Fig. 5 is a good firm hanger in three parts, the top and bottom and the lugs for holding them. The top and bottom pieces have a ¼-in. hole in each end and lugs have each a hole corresponding to these. One end is made up before installing and the other is made fast to the beam. Two flat-headed bolts connect all three parts together and fasten it in place on the beam. Fig. 6 is the same hanger applied to two beams 1 foot apart. The hanger is made to accommodate ten or twelve ½-in. conduits. The lugs are provided with hook bends on each end and a ¼-in. hole in the center for a flat-headed screw to pass through. The ends are first bent up square and then ham-

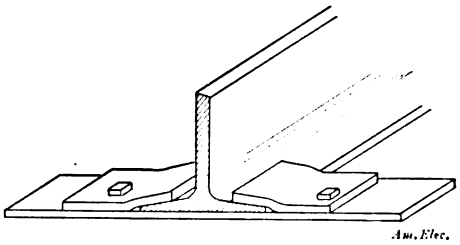

FIG. 3A.

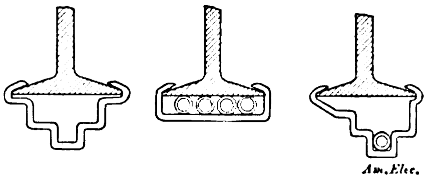

FIG. 4.

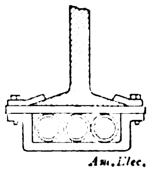

FIG. 5.

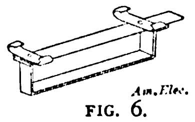

FIG. 6.

mered over the outside edges of the I-beam or girder. The other two parts are fastened to the hanging screws by small nuts on the bottom. Figs. 7 and 8 are clamps or holders used to keep the pipes uniform; these consist merely of two plain wrought-iron bars held together by means of three flat-headed bolts and nuts. Fig. 9 is a channel-iron resting on two I-beams and having a ⅝-in. hole drilled in the center. A ½-in. close nipple and two ½-in. lock nuts, one on top of the channel-iron and one inside the box, hold a conduit box to the channel-iron. Fig. 10 is a hanger of the slip-joint type, the lugs used being the same as those just described. To each C-shaped lug is attached a U-shaped loop; a loose wrought-iron bar, 2 inches wide by ⅛ in thick, laid across these loops, completes the hanger.

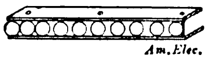

FIG. 7.

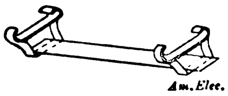

FIG. 10.

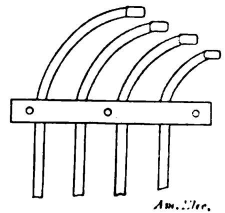

FIG. 8.

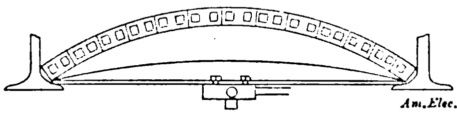

FIG. 9.

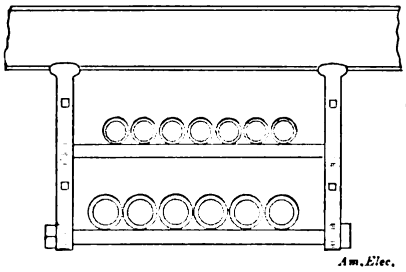

FIG. 11.

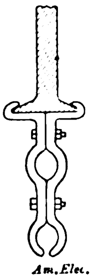

FIG. 12.

Figs. 11 to 16 illustrate hangers of a more unique and substantial nature. Fig. 11 is a double-pipe hanger arranged in such a way as to accommodate two rows of pipes, one underneath the other, and is made of ⅜-in. wrought iron. The upper bar carries ½-in. conduits and the lower 1¼-in. conduits running parallel to each other. The hanger is supported by means of two wrought-iron clamps, one end of which grasps the I-beam while the lower end is made to grasp a 1-in. pipe. For convenience the clamps are made in two parts and held together by short ⅜-in. bolts and nuts, as shown in Fig. 12. The 1-in. pipe which serves as the bottom hanger is provided with thread and lock nuts to prevent it from shifting. Fig. 13 is a hanger that can be used at the crossing or intersection of two beams. The lugs and loops are made from a wrought-iron bar ¼ in. x 1 in. and holding a piece of wrought iron 15 in. long and 4 in. wide. The single loop is attached to one beam and the other two to the beam meeting it at right angles; a wrought-iron bar is laid on the single loop and the main hanger, thus providing for lines running in both directions. Fig. 14 is an arrangement used in places where no beams are to be had in the line of piping, as in the center of an arch. When the distance between beams is not more than 5 feet the plastering can be dug out and a channel-iron inserted extending from one to the other and resting on the flanges, as shown.

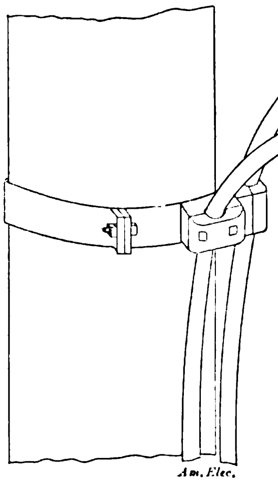

FIG. 15.

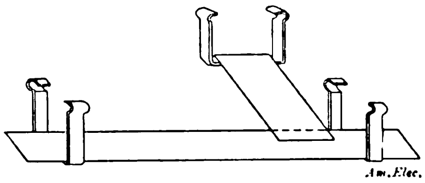

FIG. 13.

Figs. 15 and 16 illustrate hangers for use with heavier pipes and open cables of over a million circular mils, as in six-wire cable. Fig. 15 is a pillar support arranged to hold four or more extra heavy cables. It is of extra heavy wrought iron, ½ inch thick, made to form a complete circle and arranged in two parts for easy adjustment. One-half of the hanger has several ¾-in. holes equidistant from each other. The holes are tapped with a bolt thread and the cast-iron holders bolted on, sunken bolts being used. The two parts of the band are held together around the pillar by ½-in. bolts and nuts. Fig. 16 is an extra heavy U-shaped hanger, applicable to both wrought-iron I-beams and wooden beams. Those designed for I-beams have adjustable lugs and those for wooden beams or joists have ½-in. holes for lag screws. They are used on 3 or 4-in. pipe. The principle of installing piping is a simple one. The hangers should be installed first and then the pipe can be run easily. Never attempt temporary hangers, if they can be avoided, as they are a great handicap.

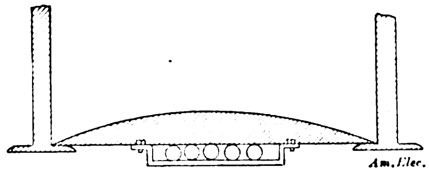

FIG. 14.

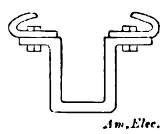

FIG. 16.

PUMPS IN CENTRAL STATIONS.

BY W. T. EDWARDS.

As a factor in the economical operation of a power plant, the pump occupies a position that is second in importance to hardly any other machine. The increase in economy obtainable by the use of the condenser is made possible only by the use of the circulating and vacuum pumps.

The gravity oil systems which are so familiar in up-to-date stations are also a great convenience and source of labor-saving in connection with which the pump again maintains its claim to a prominent position.

In the matter of boiler feeding the pump has a competitor in the injector, many types of which are used for that purpose, but the pump is superior to the injector on account of its better economy and its ability to handle heated water, which the injector cannot do.

Again, the pump is invaluable as a means of protection against fire; many plants are provided with special fire pumps built to meet special requirements of the fire underwriters.

The other uses to which pumps are put, when fluids or semi-fluids are to be moved from one point to another, either at the same or a higher level, are many, but will not be touched upon in this article.

In connection with condensers, the number and kind of pumps necessary will vary with the kind of condenser used; some condensers requiring two pumps and others but one. On the kind of condensers will also depend the size of the pump required to handle the circulating water, since jet condensers require about 30 pounds of water to condense one pound of steam, while in the surface condenser about 50 times the volume of the feed water is used. This large quantity of water may be handled by almost any type of pump of sufficient capacity. Centrifugal pumps are frequently used as circulating pumps, but more often one of the reciprocating type is used with both jet and surface condensers.

In the case of the surface condenser two pumps are necessary, the air pump, also called the wet vacuum pump, which takes care of the water of condensation together with the entrained air; and the circulating water pump, which supplies the water for condensing the steam. These pumps are usually directly connected to the condenser outlets, but this is not imperative; the pumps may be placed at any convenient point and connected to the condenser by pipes, the air or wet vacuum pump being located so that the water of condensation will flow into it by gravity. When jet condensers are used, one pump takes care of both circulating water and water of condensation, together with the entrained air. The circulating water is drawn into the condenser head, where it meets and condenses the exhaust steam from the engine, the whole being drawn through the pump and discharged into a hot well or to waste.

It will be evident from the foregoing that, as the pump with the jet condenser performs the same work as the two pumps with the surface condenser it must be of greater capacity, but it is more economical and is the most common arrangement, unless it be desirable to return the water of condensation to the boilers.

The barometric tube jet condenser requires a type of air pump that may be considered a special air compressing pump, and which is called a "dry vacuum" pump; it is required to receive air at exceedingly low pressure and discharge it against the pressure of the atmosphere. The condensing chamber of the barometric condenser is mounted on a vertical air-tight tube or pipe not less than 34 feet high, the lower end of which is sealed in a hot well or receptacle for holding water. The operation is somewhat as follows: The circulating water is discharged from the circulating pumps into the chamber from one side where it strikes a cone or serrated plate which causes it to break into a spray in the case of a serrated plate being used, and a thin cone-shaped film when the cone is used. Diametrically opposite, the exhaust steam enters, and, passing through this spray is condensed, the whole dropping into the barometic tube, thence into the hot well, passing over the side of the well to waste, or else being pumped back into the boilers. Some of the air that is entrained in the steam passes out through the tail pipe, as the barometric tube is sometimes called, with the circulating water and what remains rises to the top of the condensing chamber and filling it, would soon destroy the vacuum were it not removed. It is the purpose of the dry vacuum pump to remove this air, therefore it is connected to the top of the condensing chamber. Means are provided for the purpose of cooling this air to the lowest possible temperature, the reason for this being that the volume of air is directly proportioned to its absolute temperature,* a pound of air at 80° F. having about 90 per cent of the volume of a pound of air at 140° F.; consequently, the work of a pump is directly proportional to the absolute temperature* of the air.

Whatever the degree of vacuum in the condenser, there must be a still higher degree of vacuum in the pump cylinder in order that this rarefied air will pass into it. And in order to reduce friction, there must be an ample and free passage between the condenser and the pump. After the air enters the pump cylinder it must be compressed to a pressure greater than the atmosphere, so that it will discharge into it; because of this the pump does as much work as it would were it to compress the same weight of air from the atmospheric pressure to a pressure of about 120 lbs. This work requires that the pump be treated like an air compressor; it is water jacketed, and in some cases made in two stages; the clearances are in all cases reduced to the smallest practical amounts and the valves and valve seats are especially designed for these exacting conditions.

The direct acting type of steam pump is usually used for boiler feeding purposes, though the vertical triplex type of power pump is sometimes employed and gives excellent satisfaction. This is usually driven by a motor geared to the pump by a speed-reducing train of gears. Sometimes the pumps are driven by belts from a countershaft. Where boiler feed pumps are electrically driven, alternate means are usually provided to feed the boilers independently of these pumps, as an accident to the supply of power might be a serious matter.

Boiler feed pumps are generally installed in duplicate, each of sufficient capacity for the entire installation of boilers, or at least, for all the boilers that will be in use at one time. This provides for an emergency such as the disabling of one of the pumps. The pumps are sometimes placed side by side at the center of the boiler house and discharge into the middle of a feed water main, which runs along the fronts of the boilers. Another way is to have the pumps placed one at each end of the boiler house, supplying the feed line from either end. Either way is good, but the latter arrangement requires more pipe for both the steam lines and the suction line.

TABLE I.

Vacuum inches mercury.	Air pressure in suction pipe in lbs. per sq. in.	Calculated lift in feet.	Actual lift in feet.
1	14.21	1.13	0.90
2	13.72	2.26	1.80
3	13.23	3.38	2.71
4	12.74	4.51	3.61
5	12.25	5.64	4.51
6	11.76	6.77	5.41
7	11.27	7.90	6.32
8	10.78	9.02	7.22
9	10.29	10.15	8.12
10	9.80	11.28	9.02
11	9.31	12.41	9.90
12	8.82	13.54	10.83
13	8.33	14.66	11.73
14	7.84	15.79	12.63
15	7.35	16.92	13.54
16	6.86	18.05	14.44
17	6.37	19.18	15.34
18	5.88	20.20	16.16
19	5.39	21.43	17.15
20	4.90	22.56	18.05
21	4.41	23.69	18.95
22	3.92	24.82	19.85
23	3.43	25.94	20.76
24	2.94	27.07	21.66
25	2.45	28.20	22.56
26	1.96	29.33	23.46
27	1.47	30.46	24.36
28	0.98	31.68	25.27
29	0.49	32.71	26.17
30	0.00	33.85	27.07

In the case of fire pumps the board of underwriters requires that they be capable of delivering their rated capacity without hammering and that they be able to run at double the speed of boiler feed pumps or any ordinary water supply pumps. Therefore the fire pump should be stronger, be better constructed, having large steam valve ports and larger suction valve areas than the ordinary pump. It is required that duplex pumps alone be used, and it is recommended that when more than 1000 gallons per minute capacity is required, two pumps be used, estimating that the above amount will suffice for four streams. This allows 250 gallons per minute for a good 1⅛-in. fire stream. These pumps are usually built to withstand the sudden shocks due to turning a full head of steam into a cold pump, which is quite likely to happen when one is under the excitement produced by a fire. Where a fire pump is left standing unused for perhaps months, the rubber valve discs are apt to stick to the seats, and if the lift is very high there may not be pressure enough to open all of them. It is a good plan to work the fire pump at least once in four weeks in order to have everything limbered up. A fire pump should have a vacuum chamber, which may be a vertical piece of pipe of the same diameter as the suction pipe, and about 6 feet long, closed at the upper end. A large air chamber is necessary in order to prevent the hose from vibrating so as to cause holes to be worn through. The pump should have a priming pipe leading from a tank containing water used for no other purpose. A pump rigged with a provision for priming surely and quickly may have the suction pipe without a foot valve. Of course if the pump takes the water under a head the priming outfit is not needed, but openings for priming pipes should be left in the pump shell and fitted with plugs.

In the gravity oil system the oil is stored in tanks elevated above the bearings to be lubricated, flooding the bearings with a pressure varying with the height of the tanks. After passing through the bearings the oil passes through pipes to a system of filters, thence into settling tanks from which it is pumped back into the storage tanks. The pumps used here are almost invariably of the duplex type and are as a rule installed in duplicate. They are piped, with regard to the exhaust pipe, so that the exhaust steam may be passed through a coil in the settling tanks for the purpose of heating up the oil in case it becomes desirable to thin it so that it will flow freely. It is also customary to provide means for circulating cold water through this same coil for the purpose of thickening the oil should it become too light.

Table I shows practical heights to which water can be raised by ordinary pumps at sea level, assuming that the practical lift is 0.8 of the theoretical lift; both the theoretical and practical lifts are given.

That the ordinary pump will not handle hot water without injury to the valves and packing and that no pump will lift hot water are facts well known to everyone who has to do with pumps. Why the hot water injures the valves and packing is not a hard question to answer, but why a pump will not lift hot water is not generally known. The temperature at which water is converted into steam varies with the pressure on the water; at atmospheric pressure the boiling point is 212° F.; under 150 pounds absolute pressure the temperature at which steam is made is 358° F., while under a pressure of 4 pounds absolute, steam is produced at a temperature of 153° F. The reason a pump will not lift hot water is that when the piston moves so as to produce a partial vacuum, the pressure on the hot water is relieved so that it is immediately converted into steam, and the pump draws in nothing but the steam so produced.

When water is heated to a temperature of over 120° it is necessary to arrange the pump or the source of supply so that the water will flow by gravity into the pump. When this arrangement can be secured the successful operation only depends on selecting a suitable pump and valves. A composition of rubber and graphite makes a good valve for hot water and in some cases metal valves are used. The pistons are packed with metal rings or are constructed with what are called "water rings"; these latter consist of shallow grooves turned about the circumference of the piston which fill with water. The reason these grooves are effective is that a sudden enlargement in any cavity through which water is forced induces currents in the cavity that impede, if they do not prevent, a direct passage of water. Because of the difficulty of handling hot water it is customary to place the boiler feed pump so that the feed water is forced from the pump through the feed water heater and thence into the boilers.

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*Fahrenheit temperature + 460.

Sometimes pumps take their supply under pressure, for instance, where the water used is from the city mains. This pressure varies with local conditions and under no conditions is it uniform. This makes a uniform speed of the pump almost impossible and in the case of boiler feeding a variation of speed in the pump causes the water level in the boiler to vary objectionably. Boiler feed pumps taking their supply under such circumstances should be watched very closely in order to maintain even an approximately uniform water level or steam pressure in the boiler. The reason for the variation in speed of the pump is that the steam pressure on the pump piston is practically uniform and when the opposing pressure due to the column of water which the pump moves is reduced by the pressure in the mains tending to help push this column of water along, the steam pressure exceeds the back pressure too greatly and the pump runs away.

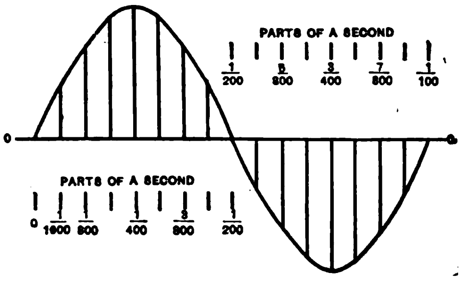


FIG. 1.

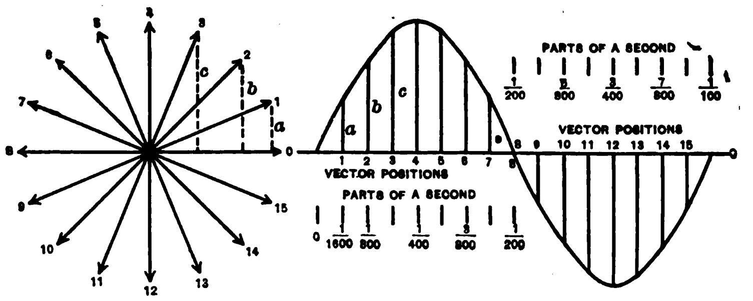


FIG. 2.

There are several methods of controlling the pump speed; one is to place a reducing valve in the suction pipe; another is to throttle the supply by causing the pump to draw the water through the valve. By far the best method is to use a pump governor which maintains the speed practically constant under widely varying pressures.

Lessons in Practical Electricity

ALTERNATING-CURRENT DIAGRAMS.

If a polarized current indicator could be made so free from inertia as to follow the rise and fall of an alternating current like the piston of a steam engine indicator follows the rise and fall of steam pressure, a pencil attached to its needle or pointer and arranged to move to and fro across a moving strip of paper would trace the "current wave" of the generator when the instrument was inserted in series with the circuit; connecting the instrument across the terminals would cause the pencil to trace the "e.m.f. wave" of the machine. For convenience in calculations, these curves are assumed to have the form of a sine curve, as shown by Fig. 1. In practice many machines do give a wave which approaches very closely to a true sine wave.

In Fig. 1 the spaces along the zero or datum lines may be considered intervals of time in fractions of a second. With a frequency of 100 cycles per second, it requires only 1-100 second for a complete cycle, which consists of one positive and one negative impulse, from zero back to zero. Considering the horizontal divisions as intervals of time, the vertical lines would indicate the e.m.f. at instants 1-1600 second apart, as indicated by the figures on the diagram. If there were no such thing as phase difference the curve diagram would fulfil all the requirements, but when currents or electromotive forces, or both, rise from zero to maximum at different intervals of time their mathematical relations cannot be so readily determined from curves as from a system of "vectors."

For convenience, therefore, a cycle, or complete reversal of current or e.m.f. as indicated by Fig. 1, is represented by the rotation of a "vector" about its origin, just as the hand of a clock rotates about the spindle, one revolution representing a cycle. The length of the vector is made to represent the maximum value of the e.m.f. or current, as the case may be, and the distance from the zero line to the outer end of the vector, measured vertically, represents the value of the e.m.f. or current at that part of the cycle indicated by the position of the vector. The latter is usually assumed to rotate left-handedly or counter-clockwise. Fig. 2 shows the relations between the position of the vector and the time intervals of the cycle. Sixteen positions are shown, for simplicity, but it will readily be understood that if the circle described by the vector be divided into 360 parts, as a circle is usually divided, the relation holds throughout, for each degree or fraction of a degree.

If the current in a line lags behind its e.m.f. to such an extent that it does not attain its maximum value until the e.m.f. has fallen back to zero and is about to reverse, as indicated by Fig. 3, it evidently lags one-fourth of a cycle ahead of the reversal of the current. This condition is shown by two vectors having a common origin but being angularly displaced by a fourth of a circle, as shown by Fig. 4. The current is then said to lag 90° (one-fourth of a complete circle), or to be "out of phase" with the e.m.f. by 90°. In comparing phases the zero line is usually omitted, as the object of the diagram is to show merely the phase relations and not the instantaneous values. Consequently it does not matter whether the diagram be drawn as in Fig. 4 or in Fig. 5. The main point is the difference in phase.

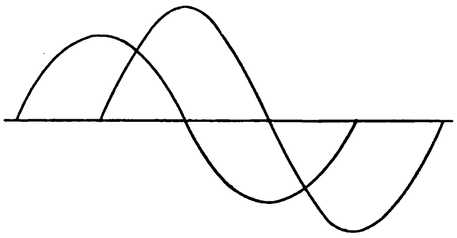


FIG. 3.

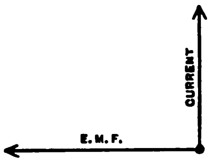


FIG. 4.

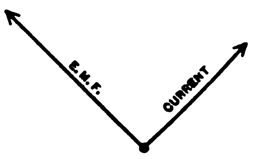


FIG. 5.

Difference of phase between two or more e.m.fs. or currents are also represented by vectors. For example, a two-phase generator supplies two distinct electromotive forces which are of equal value but a quarter of a cycle apart in phase; that is, when one is at zero the other is at maximum. This relation is shown by two vectors of equal length, 90° apart, as in Fig. 6. As in the previous case, it does not matter whether one is horizontal and the other vertical, as in Fig. 6, or whether each forms an angle of 45° with the vertical, as in Fig. 7, or what their position in space is; the important fact is that they are 90° *from each other.*

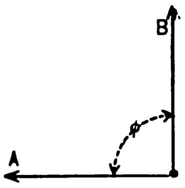


FIG. 6.

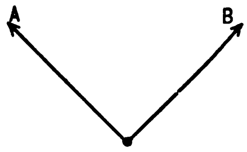


FIG. 7.

The chief convenience obtained by the use of vectors in alternating-current work is in computing the combined effect, or, to express it properly, the resultant, of two or more e.m.fs. or currents which differ in phase. For example, if the two e.m.fs. represented by the vectors A and B, in Figs. 6 and 7, are connected in series, the resultant e.m.f. may be plotted by drawing two lines parallel with the two vectors, as indicated by the dotted lines in Fig. 8, and drawing in a diagonal across the square just formed. The diagonal represents both in length and phase relation the resultant e.m.f. produced by the two original e.m.fs., A and B, combined. If these e.m.fs. are 100 volts each, the resultant will be 141 volts, and it will be ⅛ cycle or 45° ahead of the e.m.f., B, and the same distance *behind* the e.m.f., A. The formula for the resultant of two equal e.m.fs. differing in phase and connected in series manner is:

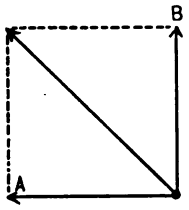


FIG. 7.

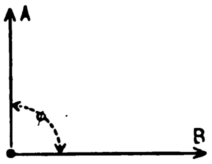


FIG. 9.

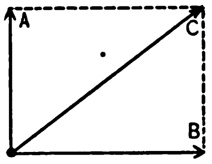


FIG. 10.

$$2 \times A \times \cos (\tfrac{1}{2}\phi),$$

ϕ being the phase angle between the two e.m.fs. This formula applies regardless of the phase difference, but is only applicable to two e.m.fs. of equal value. When two e.m.fs. having different values are combined, as indicated by Figs. 9 and 10, if they are at right angles or 90° apart, the formula for the resultant is:

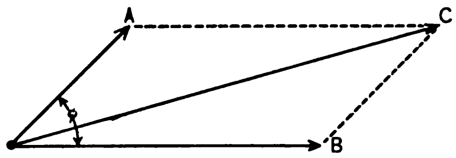


FIG. 11.

$$\sqrt{A^2 + B^2} = C.$$

This is a case frequently met in practice in calculating the e.m.f. necessary to be applied to the terminals of an inductive load, such as an electro-magnet, on an alternating-current circuit. The vector, B, in the diagram represents the e.m.f. required to overcome the resistance of the winding, and the vector, A, represents the e.m.f. required to overcome the reactance or inductive opposition, which is always 90° from the resistance e.m.f. The vector sum of these two is the e.m.f. required at the terminals of the coil. For example, the diagram is plotted to a scale of six volts for A and eight volts for B, and the vector sum of these two, instead of being 14 volts, which is the arithmetical sum, would be 10 volts. The scale of the diagram is one-eighth of an inch per volt, and a scale applied to the vector, C, will show that it is 10/8 long, corresponding exactly to the result of the formula.

When the difference in phase between the two e.m.fs. or currents is other than 90, and the two e.m.fs. or currents have also different values, as indicated in Fig. 11, the calculation is more complicated, the formula being:

$$\sqrt{A^2 + B^2 + 2AB \cos \phi} = C,$$

in which ϕ is the angle between the two vectors, A and B, as indicated in the diagrams. The cosine of any angle may be taken from a table of sines and cosines such as the various engineering handbooks contain.

When three or more e.m.fs. of different phases are to be combined, two of them are first combined, then the result of these two is combined with the third, and so on, until all are combined. The commonest case of this kind is found in a transformer diagram. Fig. 12 is a part of such a diagram relating to the primary winding; the vector, E_r represents the voltage required to overcome the resistance of the primary winding, and which is in phase with the primary current; E_x is the e.m.f. necessary to overcome reactance, which is 90° out of phase with the resistance drop, as already explained, and E_i is the e.m.f. required to overcome the counter e.m.f. of the transformer. The resultant of these three will be the e.m.f. required at the terminals of the transformer, as this must balance all of the internal e.m.fs.

The first operation is to combine E_r and E_x; the resultant of these two is E_z and shown by Fig. 13, and this vector represents not only the strength but also the phase of the resultant e.m.f. Having resolved E_r and E_x into E_z, this must be combined with E_i, as shown in Fig. 14, giving the resultant E, which is the vector sum of E_r, E_x, and E_i.

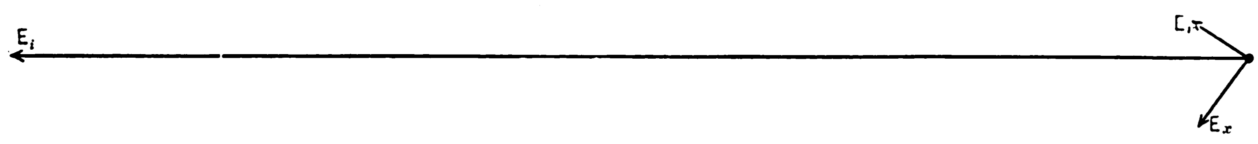


FIG. 12.

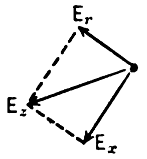


FIG. 13.

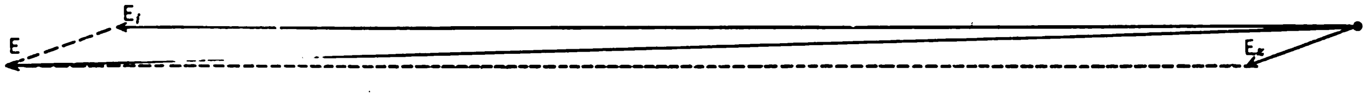


FIG. 14.

The student will find it profitable to make a memorandum of the general rule that vector diagrams and calculations apply to e.m.fs. connected in series and currents combined in parallel; also that all of the currents and e.m.fs. treated in a given diagram or formula must have the same frequency.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Connecting Three-Wire Generators in Parallel.

To the Editor, American Electrician:

Having had to face the problem of connecting three-wire generators in parallel, and finding it not quite so simple as it appeared at the outset, it occurred to me that your readers might like to consider the features that are involved. In the first place, the generators must compound for an increase in load on either side of the three-wire system; in the next place, connecting two or more such generators in parallel necessitates the use of equalizer connections between them, of course. I send herewith the diagram of connections that I used, and would be glad to have readers work out diagrams and submit them for comparison in a future issue of your paper.

Brooklyn, N. Y. Geo. W. Malcolm.

[We withhold Mr. Malcolm's diagram for comparison with those of any readers who may desire to submit their own methods of connecting up.—Editor.]

◆

A Mild Problem in Motor Operation.

To the Editor, American Electrician:

The plant in which I am working includes a number of 500-volt motors, and several of these "blew" their fuses recently under circumstances which may be of interest to your readers. A 10-h.p. motor drives a gang saw, three 7½-h.p. machines drive "rubbing beds" and a 5-h.p. motor drives other machinery. The 10-h.p. machine is fused at 40 amperes, the 7½-h.p. motors at 20 amperes each and the 5-h.p. motor at 15 amperes.

The saws driven by the 10-h.p. motor stuck in the work, stalling the motor and blowing its fuses; the fuses of the 5-h.p. motor and two of the 7½-h.p. machines immediately blew also, but those of the third 7½-h.p. motor did not; the lever of its starting box fell back to the "off" position. I should like to have readers of the American Electrician offer an explanation of the results of the initial trouble with the 10-h.p. motor.

Cleveland, Ohio. Harold Notholf.

Sprung Tubes in Water-Tube Boilers.

To the Editor, American Electrician:

Referring to the letter under the above heading, on page 547 of your October issue, and signed by J. C. Fuller, Poughkeepsie, N. Y., which shows a cut of our Keeler water-tube boiler, we desire to call your attention to the fact that the boilers at the plant in Poughkeepsie are not Keeler boilers, so that the use of this cut is rather misleading as showing our boiler in connection with the troubles mentioned in the article. While we are always willing to have a free advertisement we would prefer to be advertised in some other way.

E. Keeler Company.
Wm. E. Gray, Ass't. Gen'l Mgr.
Williamsport, Pa.

[As the illustration referred to was sent to us by our correspondent, we are, of course, not to blame for the error. Mr. Fuller writes us that he clipped the illustration from an engineering paper and sent it with his letter merely to show the general type of the boilers referred to, but did not expect it to be published. As he did not explain this in his first letter, and we had no means of knowing that the cut did not illustrate the boilers actually in his plant, we naturally supposed the picture was for use in connection with his letter. The boilers in question are, of course, not Keeler boilers, but even if they were we should not consider the reference uncomplimentary to the Keeler Company; tubes in this class of boiler do not spring on account of faulty construction or material as a rule, but because of some abnormal condition of operation. However, we regret the error quite as much as anyone concerned.—Editor.]

Mr. Pool's Problem in Bell Wiring.

To the Editor, American Electrician:

I enclose herewith a solution to Mr. Pool's problem in bell wiring which appeared in the October number. Only one pair of wires is required. These are connected as shown in the sketch to the push button, *c*, in the parlor and at *x* and *y* in the kitchen; putting the door opener, *d*, and the bell, *e*, in series when the button in the parlor is pushed. Since the bell does not have the full potential of the battery across it, the difference in the intensity of sound is easily distinguished and the vibration of the armature on the bell keeps the door opener from sticking.

Brooklyn, N. Y. Paul Watrous.

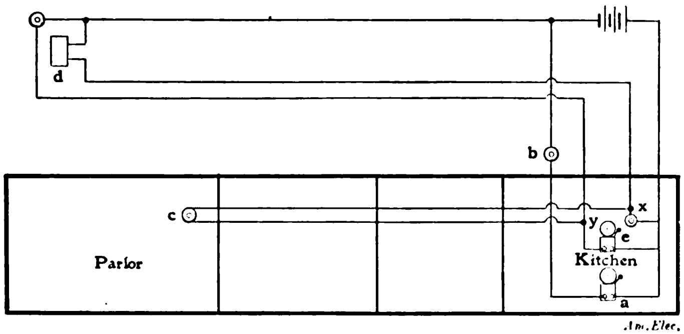


FIG. 1.—MR. WATROUS'S SOLUTION.

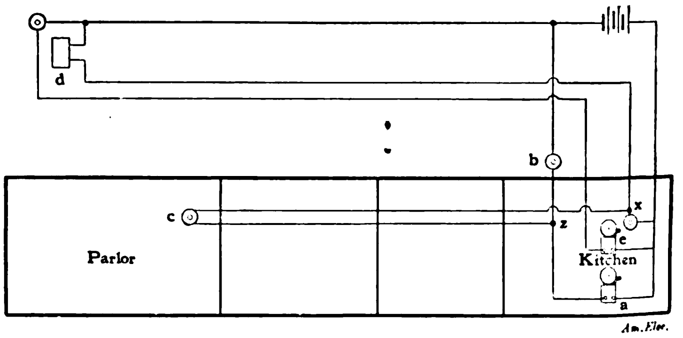


FIG. 2.—MR. M'BRIDE'S SOLUTION.

[Solutions identically the same as that shown by Mr. Watrous in Fig. 1 were received from J. J. Marshall, San Francisco, Cal.; J. Siddall, Kearney, N. J.; H. A. Fiske, Kingston, R. I., and L. M. McBride, Denver, Colo.]

To the Editor, American Electrician:

I enclose herewith a sketch of connections which I believe will meet the requirements of Mr. Pool's problems in bell wiring. One line from the button, *c*, in the parlor, is connected at *x* and the other at *z*, which places the bell, *a*, the push button, *c*, and the door opener, *d*, in series.

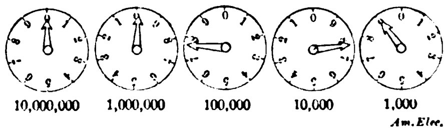
Denver, Colo. Lewis M. McBride.

[Solutions substantially like the above were received from M. H. Williamson, Athens, Ohio; J. Glogan, New York; M. S. Bassett, Birmingham, Mich.; W. J. Southeimer, Cleveland, Ohio; F. E. Du Bois, Troy, N. Y., and J. W. J. Manning, South Boston, Mass. These solutions differ from Mr. Watrous's only in the choice of bell. In Mr. Watrous's solution bell *e* rings, whereas in Mr. McBride's solution bell *a* rings. Numerous solutions were received requiring a three-point switch and three wires, together with an extra battery; but these solutions are inadmissible according to the conditions of Mr. Pool's problem.—Editor.]

Mr. Zimmerman's Tricky Meter Reading.

To the Editor, American Electrician:

I wish to submit the following solution of the meter-reading problem presented by Mr. Zimmerman in this department of the October number:



TRICKY METER READING.

The first pointer (extreme right-hand dial) obviously indicates 900. The next one, having passed 7 and not yet reached 8, indicates 7; this is also true of the third pointer. The pointer of the fourth dial appears to be at 0, but it cannot be quite there because the preceding one has not yet completed its revolution; the fourth pointer, therefore, must be read as at 9. The fifth one is the one involving the "catch." If the meter had recently started from complete zero, all the other pointers being in the positions shown, the fifth pointer would be not quite at 1, the preceding one having not quite reached 0. As it (the fifth hand) is not near 1, it must be considered not quite at 0, so that it still indicates 9. The reading, therefore, is 9,977,900.

New York. John S. R. Bell.

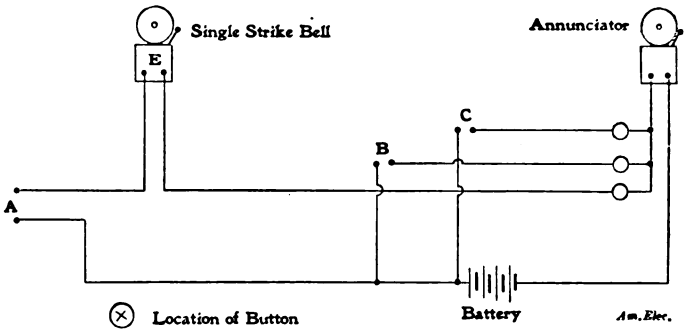
[The foregoing solution is correct. The correct reading has been sent in also by W. M. Aiken, Bennington, Vt.; R. C. Barton, Alameda, Cal.; Abel Beule, Memphis, Tenn.; James B. Dillon, Louisville, Ky.; George W. Graham, Champaign, Ill.; Frank Harris, Sackville, N. B., Can.; B. F. Hessom, Aspinwall, Pa.; Fred. Knowlton, Ashland, Wis.; R. R. McCreary, Kansas City, Mo.; C. H. Pool, New York; Leon C. White, Brattleboro, Vt.; Samuel Wilkinson, Northville, Mich.; M. H. Williamson, Athens, Ohio.—Editor.]

Problem in Bell Connections.

To the Editor, American Electrician:

I enclose herewith a problem which might interest your readers to solve. In a house having a three-point annunciator, a single-stroke bell, *E*, was connected in series with button, *A*. It was desired to connect a button in the basement, so that the single-stroke bell, *E*, could be rung as a vibrator without interfering with the action of the bell when rung from the button, *A*, as a single-stroke bell, and without at the same time causing the annunciator to indicate and the annunciator bell to ring when operated from the push in the basement. Owing to the construction of the house, no wiring can be done except in the basement. The wires from buttons, *A*, *B*, *C*, and from bell, *E*, however, drop to the basement before going to the annunciator, so that no trouble need be experienced in making the necessary connections, etc. I desire to know the most practical and economical method of accomplishing this.

Buffalo, N. Y. J. Remey.



MR. REMEY'S PROBLEM IN CONNECTIONS.

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

Where can I find complete instructions for electroplating? J. J. Y.

In Philip's revision of Watt's "Electrodeposition"; price, $4.50.

If an armature coil in a Brush arc-light dynamo were wound in the opposite direction to the proper direction, would it generate the right e.m.f. if the leads were reversed? L. G.

Yes.

Are any of the features or parts of the automobile described in the July (1904) number patented? D. L. R.

No; anyone is at liberty to build the apparatus described in the article immediately following the editorial pages of each issue.

What is the formula for the horse-power developed at the pulley of a three-phase motor? E. E. Q.

Representing the e.m.f. by E, the current per phase by I, the power factor of the motor by p, and its efficiency by e,

$$\frac{E \times I \times p \times e}{430} = \text{horse-power.}$$

If electricity is a form of heat, at what temperature must a generator be to give out current? F. S. L.

Electricity is not a form of heat; the temperature of a dynamo-electric generator has nothing to do with its e.m.f. or current production. A thermo-electric generator gives an e.m.f. as soon as the active parts of its conductors are heated above the temperature of the other parts or cooled below that temperature.

Why are synchronous motors called "synchronous"? (2) Why are they not used for general service, like induction motors? T. J. M.

Because the reversals of the counter e.m.f. of the armature are always of exactly the same frequency as those of the supply current. (2) Because they are much more difficult to start up from standstill, are very sensitive to changes in frequency and (usually) will not carry as great overloads as the induction motor.

What governs the flow of current in an induction motor running at full speed under no load and running under widely varying loads? W. W. L.

The counter e.m.f. of the machine, which varies roughly with the speed; the latter varies when the load varies, being highest at no load and lowest at full normal load. The variation is, however, slight. See Lessons Department, March, April and May, 1901.

What is a "cross-compound" engine, and how does it differ from an ordinary compound engine? E. E. Q.

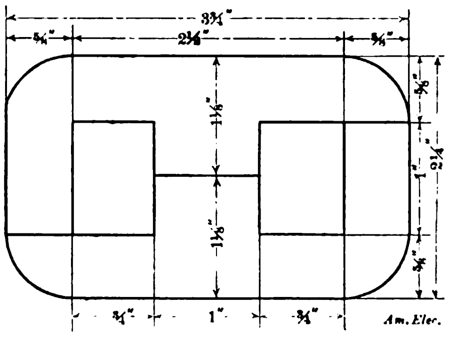
It is a compound engine with the cylinders located side by side and two piston rods connected to two separate cranks on the same shaft. A tandem compound engine has the cylinders located one behind the other, both pistons being mounted on a single rod and therefore delivering power to a single crank. Both of these are "ordinary" compound engines. Any other form is highly special.

What is the difference between the results produced by rectifiers and commutators? S. K. N.

A rectifier changes alternating current into pulsating direct current having either the same number of impulses per second as the number of alternating-current reversals or half that number. A commutator changes alternating current into almost unvarying direct current, the pulsations being negligibly small in amplitude and of a much higher frequency than those of the alternating current.

Please give data for winding the transformer core shown by the accompanying diagram; the primary to take current from a 60-cycle circuit of either 55 or 110 volts and the secondary to give 5 volts. (2) What will be the current capacity of the secondary? W. S. B.

Wind two primary coils (on the center leg) with 13 layers of No. 24 double silk-covered magnet wire, each coil to contain 230 turns; wind the secondary coil with No. 11 double cotton-covered wire, 22 turns total. Connect the primary coils in series for 110 volts and in parallel for 55 volts. The core should be built up to a thickness of 2¼ inches. (2) About 6 amperes.



What is meant by "underload release" in connection with motor starting boxes? (2) Why is it desirable? W. T. K.

The term is not quite correct; "under-voltage release" is more accurate. It is an auxiliary mechanism which releases the lever of the starting box when the circuit voltage falls below a safe working value, allowing the lever to be thrown to the "off" position by a spring. (2) For the purpose of preventing damage to the motor armature should the voltage suddenly be restored while the armature is at rest.

What are the correct applications of the terms "compensator" and "compensated"? (2) If the starting apparatus used with induction motors is a "compensator," why is not such a motor "compensated"? G. L. V.

It is difficult to say within the scope of this department. Both terms are used erroneously in many instances. "To compensate" means to make up for something that is lacking; also, to offset or counterbalance something that is present. Hence, a motor having a winding which counteracts or balances its self-induction is called a "compensated" motor. (2) Because that term is applied to a motor with a compensating winding, and it would produce confusion to apply it here. Moreover, it is rather far-fetched to call an auto-transformer starting box a "compensator."

How can I change the winding of a 50-volt, ⅛-h.p. motor to make it a 100-volt dynamo? The armature contains 12 coils of No. 23 wire, 10 turns each, and the field is wound with No. 21 wire; both wires are English gauge. E. F. B.

Rewind the armature with No. 25 wire, B. & S. gauge, 20 turns per coil; rewind the field with No. 27 wire, B. & S. gauge, to the same depth as the present winding. The machine will then run as a motor at 110 volts, but it will probably not work at all as a dynamo. Machines as small as this usually require more watts in the field winding than the armature is capable of supplying.

How does the speed of a differentially-wound motor vary with the load? (2) If direct current be passed through the armature of a direct-current shunt-wound dynamo, would an e.m.f be induced in the field winding? (3) Can the winding for an alternating-current magnet be deduced from the winding on an existing direct-current magnet of the power desired? (4) How can voltage exist without any current? T. N. S.

If the motor has been properly designed, the differential field winding causes the speed to be absolutely constant regardless of load variation; that is the object of using it. (2) No. (3) No; the calculation of magnet windings for use on alternating-current circuits involves inductance and other factors which are not encountered in direct-current work. (4) You probably have in mind *drop* in voltage; the e.m.f. or voltage must be established first in order that any current may flow; current without voltage is the impossibility, not voltage without current. Any separately-excited dynamo will generate its full voltage without a particle of current flowing in the armature; the ordinary magneto generates its full voltage without any current whatever in any of its parts.

Is it practical to use rubber-covered wires for a 10,000-volt, two-phase line 13 miles long? (2) How can the proper size of wire be determined for a four-wire, two-phase circuit? (3) Is it customary to install a separate transformer in each phase of a two-phase or three-phase circuit at points where transformation is required? G. S. D.

It is unnecessary; bare copper wire on suitable insulators is good enough. (2) Approximate the size by means of the direct-current formula

$$\frac{22 \times I \times D}{V} = d^2$$

in which I = amperes per wire; D = distance in feet; V = drop in volts, and d^2 = circular mils of wire cross-section. Assume one size larger wire and find out what the drop will actually be by means of the formula

$$V = \sqrt{(E\,p + I\,R\,)^2 + (E\,q + I\,X)^2} - E$$

in which E = voltage at delivery end; I = current per wire; R = resistance of the line; X = reactance of the line; p = power factor of the load; q = inductance factor of the load (sine of that angle of which p is the cosine). Most of the calculations may be avoided by using the tables in the article beginning on page 421 of the August, 1903, number of the AMERICAN ELECTRICIAN. (3) Yes in this country, thus far. There is a tendency to change to the European practice of using a single two-phase or three-phase transformer.

WESTINGHOUSE GAS ENGINES FOR ELECTRIC LIGHT AND POWER.

A distinctive development of recent engineering practice is the high power internal combustion engine suitable for direct connection to electric generators for lighting, power, railway, industrial, or other purposes. Constituting the only exhibit of considerable size at the Exposition, the Westinghouse gas engines operating in the joint Westinghouse exhibit in Machinery Hall are of much interest. Two types of gas engines are on exhibit, the vertical single-acting and the horizontal double-acting. Both are multicylinder machines, the former having three cylinders with cranks 120 degrees apart, and the latter two cylinders arranged in tandem with a single crank.

As the double-acting engine is of somewhat more recent introduction than the longer established single-acting type, a brief description of its most important features may be of interest. The general data regarding the unit are as follows:

Cylinders, 14½ ins. x 22ins.

Diameter of shaft, 9¾ ins. maximum; in bearings, 7½ ins.

Fly wheel diameter, 8 ft. 9 ins.

Ratio of crank to connecting rod, 1 to 5.45.

Rated capacity, 200 brake horsepower.

Length of unit over all, 27 ft. 4½ in., including fly wheel.

Width over all, 7 ft., engine, 13.3 ft., unit.

Height over all, 8 ft. 2 ins., including fly wheel.

The forward part of the engine—the frame—comprises the housing for the crosshead guide, two main bearings and a bed plate; the two cylinders and all the valve mechanism is supported by a bed plate extension bolted to the bed of the engine frame, both of which are grouted with concrete to the foundation. Cast iron exhaust pipes convey the burnt gases through the floor to a 6-inch exhaust main leading to the atmosphere. Cooling water inlet and return pipes and gas and air supply pipes rise through the floor, thus removing complex and unsightly piping as far as possible from the engine room floor.

A feature of the cylinder construction is that the cylinder, combustion chamber, ignition and exhaust parts, together with the water jackets for the respective parts, are made in one casting. In order to reduce the strains in the metal of the jackets while cooling, the jacket wall is split around the periphery, the opening being closed by a steel tension band and a strip of rubber packing. Suitable hand holes are provided at various points in the water jackets for examining the interior and to remove sediment which might be precipitated in case very dirty water should be used in the jackets.

The combustion chamber is approximately circular in horizontal section and is closed by the admission valve above and the exhaust valve below. Both valves are of the single-beat poppet or mushroom type and seat vertically along the same axis, but in opposite directions, the admission valve opening downward and the exhaust upward. The admission valve is mounted in a separate bonnet which, together with the valve, may be readily removed without dismantling any parts of the engine other than the tappet lever through which the cam motion is imparted to the valve. Both admission and exhaust valves are of steel and are held to their seats by spiral springs. The exhaust valve is water cooled. It is bored hollow throughout its length, and this canal conveys cooling water to the head of the valve; the water returns in the opposite direction through an inner concentric tube, finally emerging at the lower end. By spraying a small part of the jacket water into the exhaust pipes, the temperature of the pipe may be kept at a comfortable point through the absorption of the latent heat of evaporation of the water used.

Both pistons and the piston rod are water cooled, as well as other parts subjected to internal heat. Means for introducing the cooling water is secured by a telescopic pipe connection bolted to the inside of the crosshead guide. The inner tube of this telescopic joint is attached to the crosshead at such a point as to convey the cooling water to the end of the piston rod bore, whence it proceeds in succession through the two pistons, emerging through a bronze tail rod extending through the rear cylinder head. Each piston is a one-piece casting, cored hollow to accommodate the circulating water, and packed by cast iron packing rings set out with flat steel springs. In order to convey the water in and out of the piston, deflecting plugs are inserted at the proper points in the rod bore. A cast iron jacket surrounds the tail rod and receives the water emerging from it, whence it is drained away.

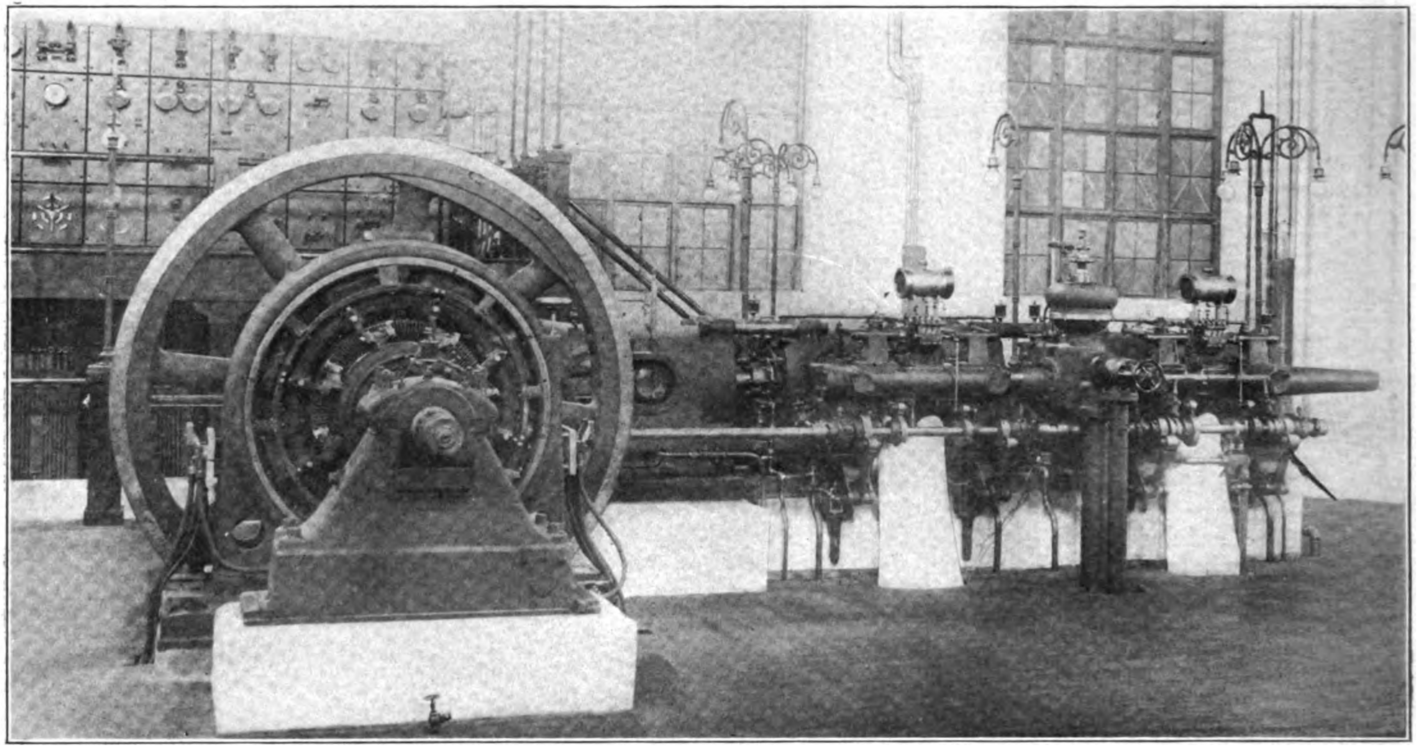


FIG. I.—WESTINGHOUSE HORIZONTAL DOUBLE-ACTING GAS ENGINE.

The many difficulties arising in providing a suitable packing gland for the cylinder heads have been overcome by means of a simple metallic packing similar in some respects to that used on high-pressure steam engines.

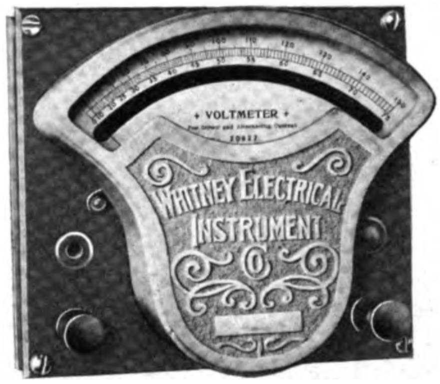
The one lay shaft paralleling the cylinders operates, through cams, all of the valve movements of the engine. Independent cams are provided for inlet valves, exhaust valves and igniters, so that the action of each valve may be timed in order to secure the best results. The main cams are all of cast iron with working surfaces chilled and ground.

The other features of the engine have been described very fully in this and other journals, so that it is unnecessary to consider them here.

New Apparatus and Appliances

NEW HOT-WIRE MEASURING INSTRUMENTS.

The Whitney Electrical Instrument Company has brought out a line of voltmeters and ammeters of the hot-wire type, on which this concern has been working for a long time past. Fig. 2 herewith is a diagrammatic illustration of the underlying principle. A wire, *a-b*, of high resistance, low temperature coefficient and non-oxidizable metal, is secured at one end to a plate, *c*, passed around a pulley, *d*, secured to a shaft, *e*, and its free end brought back again and mechanically though not electrically attached to the plate, *c*. Plate *c* is kept under stress by the spring, *f*, which constantly tends to pull it in a direction at right angles with the axis of the shaft, *e*, and is so guided that it can be moved in that direction only. To the shaft, *e*, is likewise secured an arm, *g*, bifurcated at one end and counterweighted at the other. Between the extremities of the bifurcated ends of the arm, *g*, is another shaft, *h*, on which there is a small pulley and to which is attached the needle, *i*, that gives the desired indications; a fine silk fibre is attached at one end to one of the arms of *g*, then passes around the pulley and the shaft, *h*, and has its other extremity secured to the other arm. The arms are springy and serve to keep the silk fibre taut. The current to be measured flows through the wire, *a*, only, entering and leaving as indicated by the arrows. Evidently, when *a* is heated by the passage of current, it expands, which, as *a* and *b* were originally under the same tension, makes *a*'s tension relatively less than that of *b*, and equilibrium can be restored only when the pulley, *d*, rotates sufficiently to again equalize the strain. The rotation of *d*, of course, carries *g* with it, and *g* in moving causes the silk fibre to rotate the shaft, which carries the needle. If the temperature of the air surrounding the instrument changes, *a* and *b* are affected alike and their resulting equal expansion simply results in a movement of the plate, *c*, back or forth in its path without any tendency to rotate the pulley. The advantages of the above construction are many. The zero adjustment used in this new line of apparatus is also novel. The conventional method of adjusting zero errors in hot-wire apparatus consists in varying the stress on the active wire by moving one of the abutments to which the wire is attached, a procedure which the manufacturer claims is objectionable in that the wire is a member which should be tampered with as little as possible. In these instruments the entire moving system is mounted on a single base plate that is free to rotate over a small angle around a heavy shaft secured to it immediately below and in line with shaft *h*, around which the needle swings. By means of a lever secured to this base plate and projecting slightly beyond the cap that covers the mechanism, the position of the needle relative to the scale may be altered at will without interfering with the wire in any way. While already nearly dead beat in their action, an auxiliary damping device, not shown, is employed. This consists of an aluminum disc secured to the shaft to which the needle is attached and swinging between the jaws of a small permanent magnet. The instruments are made in both portable and switchboard patterns of any range from three volts upward and two hundred milli-amperes upward. The ammeters are all worked on shunts which are contained inside of the instrument case in the small sizes and are separate in the large ones. An idea of the sensitiveness can be obtained from the manufacturer's statement that the ammeters work on shunts giving a drop of but two hundred milli-volts. An illustration of a portable voltmeter of this class is given in Fig. 1. Machado & Roller, New York City, are the general sales agents for the Whitney Company.



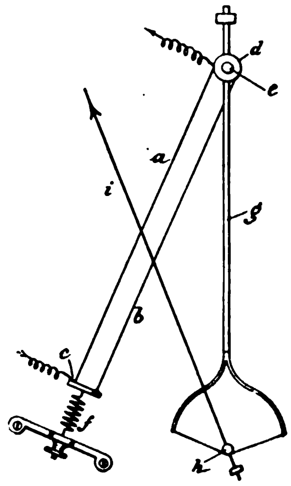


FIG. 1.—HOT-WIRE PORTABLE VOLTMETER, AND DIAGRAM OF CONNECTIONS.—FIG. 2.

HIGH-PRESSURE PACKING RINGS.

The packing ring shown by Fig. 3 herewith is made by the New Jersey Asbestos Company, of Camden, N. J., and is intended for high-pressure work. The asbestos material is molded to shape in steel dies under hydraulic pressure which the manufacturer claims results in a solid packing which at the same time retains great flexibility. The solidity of the rings prevents their being blown out of a stuffing box, and it is stated their application requires but a few minutes. The usual claims as to life and steam-tight qualities are made.

FIG. 3.—HIGH-PRESSURE PACKING RING.

COMBINED SWITCH AND CUT-OUT.

The combined switch and cut-out made by the Hart & Hegeman Manufacturing Company, of Hartford, Conn., consists of a standard 10-ampere, double-pole switch mounted on a porcelain base in connection with two cartridge fuses, all enclosed under one cover, the terminal clips being outside. When arranged for three-wire service, the porcelain base is notched as shown, so that two of these switches can be combined for use on this service. A separate porcelain block, not shown, is furnished for the purpose of protecting the branch conductors from the surface to which the switch is attached.

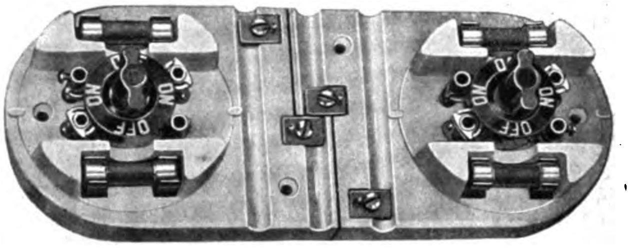


FIG. 4.—COMBINED SWITCH AND CUT-OUT.

"G. I." FLUSH PLUG AND RECEPTACLES.

The receptacle and plug illustrated herewith are said to have new and distinctive features which recommend them as strictly high-grade and efficient in design and workmanship. The body of the plug as well as the receptacle is made of porcelain. The receptacle has a side projection which engages a notch in the plug and thus renders the insertion of the latter particularly easy. Both pieces are liberally proportioned and strong, to withstand severe usage. The face plate is entirely flush when the plug is in or out of the receptacle, all of the joints being close and tight fitting. The small doors have a spring attachment which holds them either open or closed under tension. All

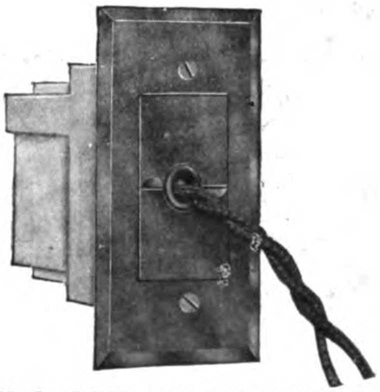


FIG. 5.—FLUSH PLUG AND RECEPTACLE.

parts have been, it is said, very carefully designed, the contact parts are flexible, and the wire inlets and binding posts placed so that the wire connections can be easily made. Unless otherwise ordered, face plates are furnished in polished brass. The size of face plate is 4¼ inches by 2½ inches. The plug and receptacle are made by the General Incandescent Arc Light Company, New York City.

MARSHALL PULL SOCKET.

The Marshall Electric Manufacturing Company, of Boston, Mass., has brought out the socket operated by bead chain pendant shown by Fig. 6. The socket is of standard size, being built upon the standard one-piece porcelain button. The cap is exactly like the cap of an ordinary socket and the shell is only varied from the standard by having a little bell attached to one side in the place of the slot for the key. The metal case is entirely lined with Elastoid fibre, all other insulations being entirely mica and porcelain. The chain pull is radial, which gives a workmanlike appearance to the socket, and there is no grating sensation of the chain rubbing through the bell, the chain being insulated from the mechanism by a short piece of woven linen Tuna line.

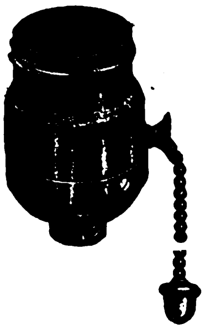


FIG. 6.—MARSHALL PULL SOCKET.

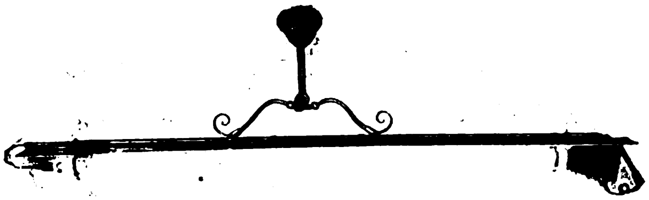


FIG. 8.—HORIZONTAL TYPE H-7 COOPER HEWITT LAMP.

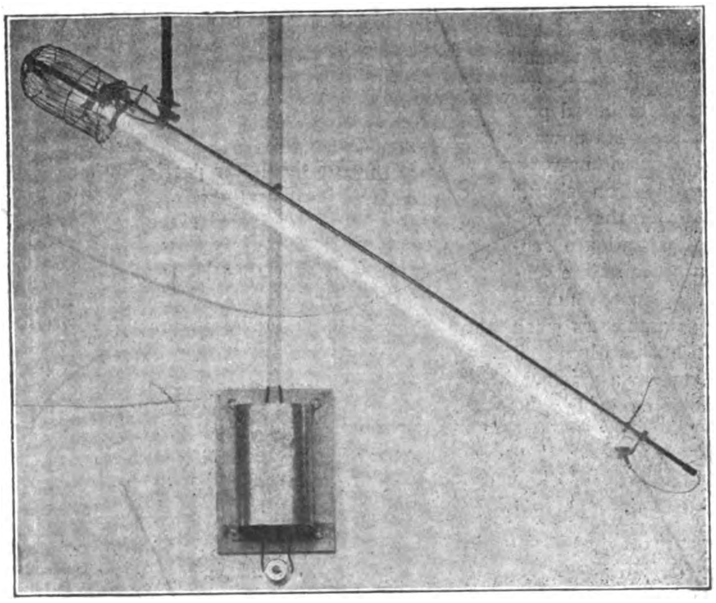


FIG. 7.—INCLINED TYPE V-5 COOPER HEWITT LAMP.

The sockets can be wired just as quickly as ordinary key sockets, the wire terminals being exactly like the standard sockets. The chain can also be detached without removing the shell.

COOPER HEWITT MERCURY VAPOR LAMP.

The mercury vapor lamp invented by Peter Cooper Hewitt and manufactured by the Cooper Hewitt Electric Company, of New York City, is shown by Figs. 7 and 8 herewith. The lamp consists of a glass tube containing a small quantity of mercury. To prevent the escape of the mercury vapor which fills the tube, it is sealed at both ends, after being exhausted to a high degree on a vacuum pump. Metal sealing-in wires convey the current to the electrodes, one or both of which are of mercury. The lamp is started by tilting the tube so that the mercury flows from one electrode to the other in a small stream. This stream momentarily connects the two electrodes, and as the stream breaks the vapor conducts the current and becomes luminous. The lamp is claimed to be the most efficient source of artificial light known. In actual service it is said to have at least double the efficiency of the arc lamp and from six to seven times the efficiency of the incandescent lamp. The color of the light, due to the absence of red rays, has a bluish-green tinge, which causes a modification of color values. Black and white are not affected, but blue and green are, of course, intensified; yellow has a greenish tint and red appears dark purple or black. Despite this characteristic the light is said to be more restful to the eye than any other form of illuminant. The length of the lamp varies with the voltage, lamps for general illumination being from 18 to 45 in. long. Light is diffused from every portion of the tube and the great extent of the luminous surface prevents the formation of sharply defined lights and shadows. The lamp is noiseless in operation and runs with absolute steadiness. The average life of the lamp is about 1000 hours, and lamps used for 2000 hours are said to show but a slight decrease in candle-power. The heat given off by the lamp is less than that given off by any other form of illuminant of the same candle-power. The lamps are made only for direct current at present, although an alternating-current lamp is being perfected. They are constructed to be operated singly on commercial lighting circuits of 50 to 150 volts. On higher voltages nearly all of the standard lamps can be run in series. All of the types are intended to be run at from 3 to 3.5 amperes. The lamps will not operate successfully where the variations in voltage are more than 8 per cent. The mercury vapor lamp can be used for general illumination and in fact any place where the incandescent and arc lamp are applicatory. For uses where actinic rays are required, as in all kinds of photographic processes, it excells all other forms of artificial light. When ordering, the actual average voltage of the supply is required, as well as the maximum and minimum variations.

P. Sorensen, of Brooklyn, N. Y., has brought out the ceiling switch shown herewith, which is unique on account of the ease with which it operates. The switch rod of the usual snap switch is extended through the back of the switch case, as shown, and a rachet and pawl affixed to the end. A cord is attached to the pawl lever and extends low enough to be within easy reach from the floor. The pawl lever is under the action of a spring, which always returns it to its normal position. One pull on the cord closes the switch and the next pull opens it. The device is merely an adaptation of the snap switch for ceiling purposes, the lever performing the operation which in the ordinary switch would be performed by the fingers.

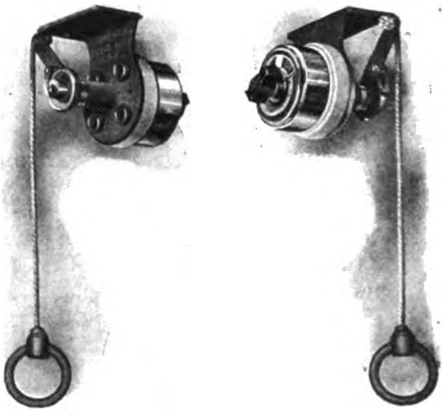


FIG. 9.—SORENSEN CEILING SWITCH.
NEW CEILING SWITCH.

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AN IMPORTANT INDUSTRIAL DEVELOPMENT.

The National Electric Company, of Milwaukee, has entered into arrangement with Robert Lundell and Robert T. Lozier, by which the National Company will manufacture and market the new motors and generators, and systems of operation and control that are covered by the latest inventions of Robert Lundell; the commercial direction of the undertaking being placed in the hands of Mr. Lozier, who will also act as general manager of the electrical sales department of the National Company. Under this arrangement Mr. Lundell assumes the direct supervision of the engineering involved under the license that he grants the National Company covering all of Mr. Lundell's inventions not already under license to other companies, and all inventions that he may hereafter make during the life of this license.

These inventions of Mr. Lundell are of particular interest in that they cover important developments in direct-current apparatus. Some of the patents are for a new type of motor and dynamo frame construction, as well as a new method of commutation, by which a material gain is obtained in the space occupied by the apparatus, its efficiency and the flexibility of its speed control and regulation. This form of construction represents an important departure in standard motors of fixed speed, and is regarded as particularly advantageous in variable-speed motors for direct application to machinery, both from the point of construction and that of flexibility of control.

As to the commercial significance of this new arrangement, it is a field with which Mr. Lozier has been associated from the earliest commercial development of the electric motor, he having been in the testing department of the Sprague factory when it was started in West Thirtieth Street in 1887. He has since followed the development of the business in all its phases. Mr. Lozier will be aided in directing the work of his department by his long experience in the electrical field, beginning with Edison early in 1883 and running down through the engineering and commercial branches of the business for 13 years with the General Electric Company and eight years with the Bullock Electric Manufacturing Company.

Mr. Samuel Watkins is the president of the National Electric Company. He organized it, and under his able direction the company has reached its present prominence. The first vice-president and general manager of the company, Mr. Frank C. Randall, is widely known throughout the electric street railway field and the air brake sales will continue as in the past, under his direct charge. Mr. Bernard T. Becker, who represents the interests of those financially back of the company, and who is himself a large stockholder and a director in the company, will act in an executive capacity in connection with the operation of the company. Of the operative force, Mr. R. P. Tell is the secretary and treasurer. Mr. J. H. Denton, well known to all those who come in contact with the air brake business, is general superintendent.

NEW BOOKS.

Photographic Lenses. A Simple Treatise. By Conrod Beck and Herbert Andrews. Second Edition. London: R. & J. Beck, Ltd., and Percy Lund, Humphries & Co., Ltd. Cloth, 320 pages, 7½ inches by 5 inches; 44 half-tone plates, numerous wood-cut illustrations and diagrams. Price, 75 cents.

This book is intended, primarily, as an argument for the Beck lenses, but contains so much information about lenses in general that it is valuable to any one who is interested in lenses or photography. The authors are anxious to improve the work, so offer three prizes for the improvement of the next edition; one for the correction of "grammar, style or matter," one for new matter and one for the best photograph taken with the Beck or Beck-Steinheil lenses. The half-tone plates are of a superior character, and make the volume attractive; the reading matter is interesting, the descriptions being lucid and concise.

Methods of Chemical Analysis and Foundry Chemistry. Second Edition. By Frank L. Crobaugh, M. S. Cleveland, Ohio, 1904. Cloth; 109 pages, 4½ inches by 6¾ inches. Price, $2.00.

This is evidently the work of a thoroughly practical iron chemist; practical, not in the sense that he is deficient in theory, as the word is sometimes incorrectly used, but in the sense that he is the master of his subject and writes things that he has done himself many times. To be sure, it is somewhat academic to give constants to ten places of significant figures, as the author does in one case, or even to eight or nine places, as he does in other cases; especially as the constants depend on such uncertain quantities as atomic weights. However, one can forgive a bit of pedantry, for the book is full of common sense; for example, the author uses a method of tabulation and inspection, in calculating the ingredients of a mixture, in preference to the method of alligation alternate. Alligations alternate is the academic method, but it is not graphic, like the tabular method, and in arranging mixtures of substances containing many constituents it becomes very complicated; besides, it is usually impossible to arrange a mixture with mathematical accuracy: all that is possible or necessary, to secure results, is an approximation within given limits. It is to be hoped that foundrymen will study the foundry chemistry, for the old rule-of-thumb foundry method, or lack of method, is an anachronism in the twentieth century.

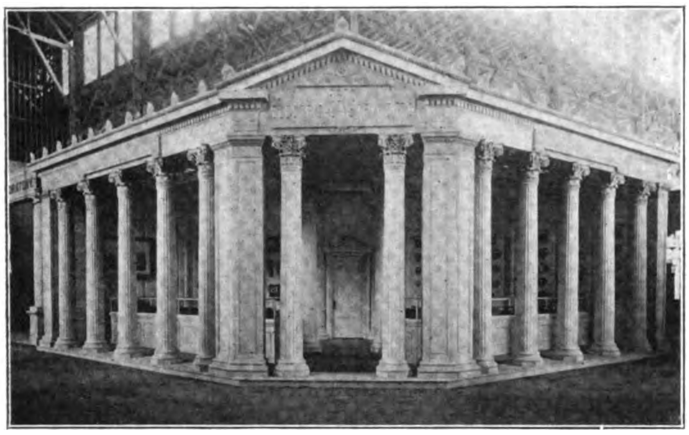
SOME EXHIBITS AT THE ST. LOUIS EXPOSITION.

WESTON ELECTRICAL INSTRUMENT COMPANY, Waverly Park, N. J., has a neat booth near the National Bureau of Standards, facing the southeast entrance of the building. This is handsomely fitted up and in it are displayed a large number of the celebrated instruments manufactured by the company. Some of the newer types recently brought out are also shown.

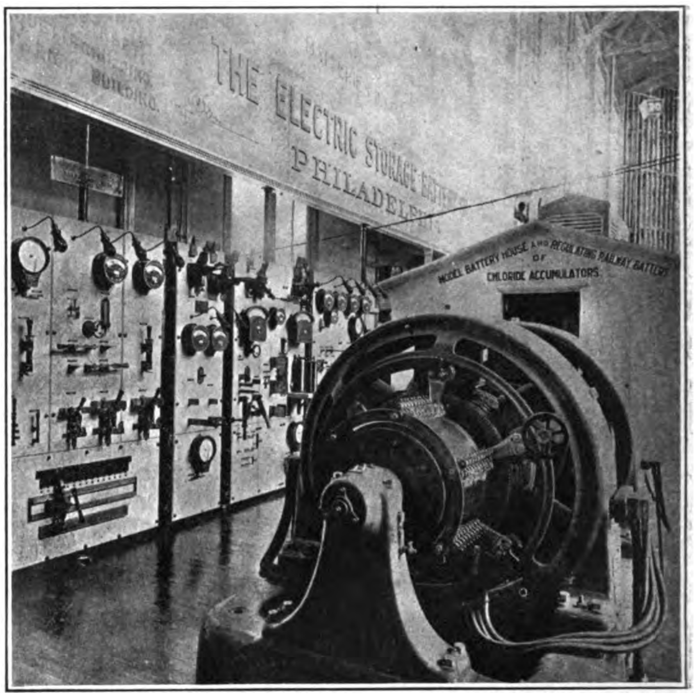
KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., has a working exhibit consisting of a 3500-subscriber exchange which is giving actual service to the officers of the Exposition and the exhibitors. The switchboard panels are identical with those recently installed in the Cleveland exchange. The company is also exhibiting its new harmonic system for four-party lines. On a table beside the generator for the working exchange are two harmonic ringers and a rack upon which are mounted several sets of apparatus adjusted to the different calling frequencies. In addition to the working switchboard, two other panels of the Cleveland type are shown, by which the construction and arrangement of all of the parts are rendered apparent. The company has also a fine display of its telephone appliances, and in an adjoining section two machines are in operation covering wire with silk.

THE HARRISON SAFETY BOILER WORKS, Philadelphia, Pa., has an exhibit at the Louisiana Purchase Exposition consisting of five Cochrane feed-water heaters and purifiers, two Sorge-Cochrane systems and fifteen Cochrane steam separators and Cochrane oil separators. These appliances are located in various parts of the Gas, Steam and Fuel Building and the Palace of Machinery, in connection with working exhibits. There are 8000 horse-power of Cochrane feed-water heaters and purifiers, in two units of 4000 horse-power each, in the exhibit of the Westinghouse-Church-Kerr Company in the east end of the Gas, Steam and Fuel Building. In the same exhibit there is located a 6-in. Cochrane vertical steam separator. In the intramural power plant there is a 1750-h.p. Sorge-Cochrane system. The Sorge-Cochrane system, which is used in connection with the Cochrane heater, provides for the chemical treatment of the feed-water in addition to the purification obtained by thermal means in the heater, so that by a simple chemical reaction the sulphates present in the water may be precipitated in the heater. Provision is also made by means of a filter bed for holding back these precipitates and other solid impurities, thus preventing them from reaching the boilers. In the intramural power plant there are also three Cochrane receiver separators, and one 40-in. Cochrane vacuum oil separator. The 14-in. Cochrane receiver separator shown in the accompanying illustration protects the pump in the Underwriter fire pump station. A 1250-h.p. Cochrane heater heats and purifies the water for the boilers in the Philippine Government Board exhibit. In connection with the exhibits of the P. DeC. Ball, Kroeschell Bros. and the Carbondale Machine Company, there are two Cochrane heaters and six Cochrane separators, ranging in size from 2-in. to 7-in. The exhibitors' power plant also includes one 1200-h.p. Sorge-Cochrane system and three 6-in. Cochrane receiver separators.

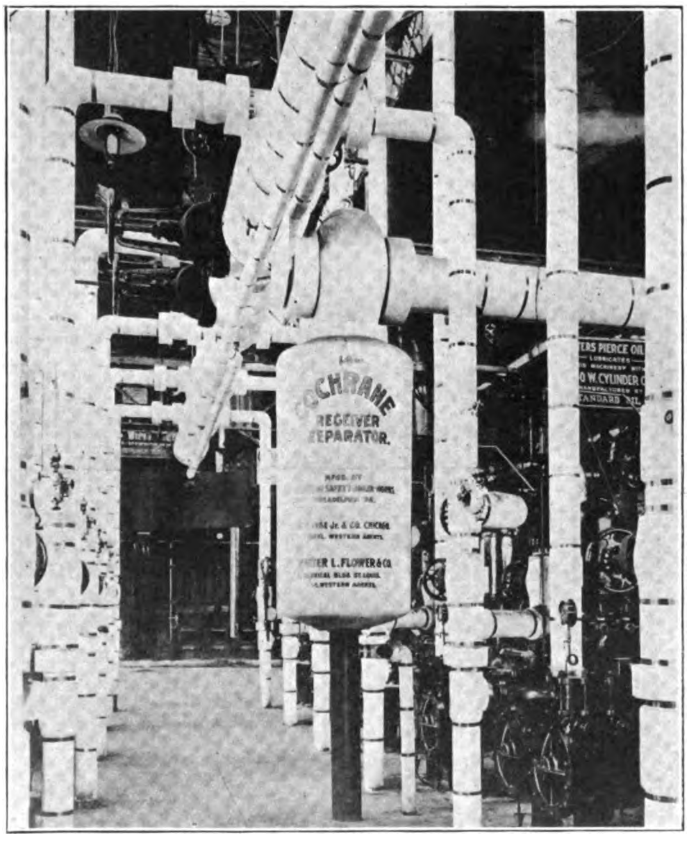
THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, Pa., has an exhibit in Section 20 of the Palace of Electricity. This is claimed to be the largest, most comprehensive and instructive exhibit ever made of storage batteries and apparatus used in connection with battery installations. One of the prominent features is a large map of the United States, about 30 by 45 feet, on which is indicated, by means of colored jewels, the location and character of the various installations of the chloride accumulator. The exhibit includes a model battery house, in which is installed a model regulating railway battery operating on a variable load. Five standard marble switchboard panels are shown, including the panels for controlling the model railway battery. The other panels are an Edison central station three-wire panel, the panels for regulating combined lighting and power loads, the railway feeder panels and panels for regulating railway power house loads. Two motor-driven boosters are also shown, the smallest being used in connection with the model battery, and the larger a standard 100-kw. railway regulating booster. Among the types of chloride accumulators are three H-61 cells, with a discharge capacity of 4800 amperes for one hour, six cells type G-77, capacity 3000 amperes for one hour, and types G-17 and F-17, all of these being in standard lead-lined wooden tanks. The smaller cells shown are types "F," "E" and "D," in glass jars, and types "E" and "D," in rubber jars, for train lighting and yacht lighting. There is also shown a very complete set of Exide cells for automobiles, and Exide sparking sets for gas and gasoline engine ignition. The Exide exhibit includes a large easel, showing in detail the various component parts of the Exide battery. At one end of the space is a group of three large end cell switches, operating from the Edison three-wire panel. The model battery, with its booster and switchboard. forms a very interesting working exhibit. The battery is of type E-15, in lead-lined wooden tanks, and is mounted on white enamel brick tiers. The battery is in every particular an exact model in miniature of the larger railway installations. It is insulated from the brick tiers by means of standard double insulation, consisting of vitrified bricks, then glass insulators, then prepared wood stringers and another set of glass insulators. On the switchboard controlling the model battery are the necesary switches and automatic circuit breakers with their interlocking devices, a recording voltmeter and other instruments, consisting of voltmeter, battery ammeter, the generator ammeter and the total load ammeter. The conditions under which the model battery operates are exactly similar to street railway conditions. With the battery regulating, a load of 300 amperes is thrown on the system, causing a drop in the lighting or generator circuit of less than one volt in 110, and a rise in current in the line, or generator circuits, of less than 7½ per cent of the total load. The action of the battery is automatically controlled by the small booster and its carbon regulator.



WESTON ELECTRICAL INSTRUMENT COMPANY'S EXHIBIT.


THE ELECTRIC STORAGE
PHILADEL
MODEL BATTERY HOUSE AND REGULATING RAILWAY BATTERY OF CHLORIDE ACCUMULATORS.

THE ELECTRIC STORAGE BATTERY COMPANY'S EXHIBIT.

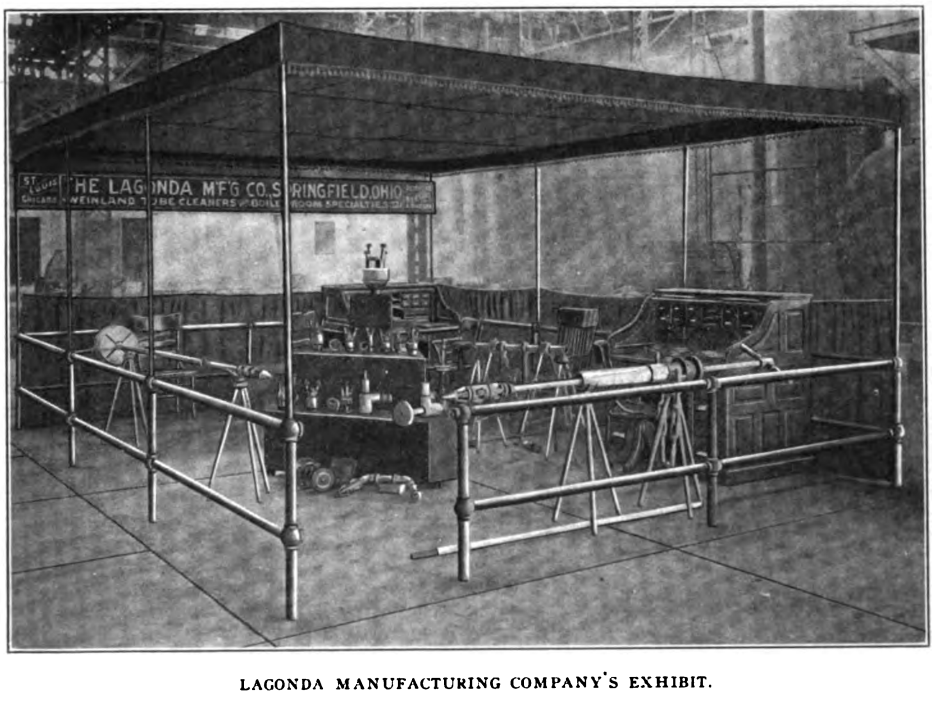


HARRISON SAFETY BOILER WORKS' EXHIBIT.

SWITCHBOARD

KELLOGG SWITCHBOARD AND SUPPLY COMPANY'S EXHIBIT.

THE LAGONDA MANUFACTURING COMPANY, of Springfield, Ohio, has an exhibit in the Steam, Gas and Fuel Building, where, in the midst of a lot of boilers of different makes, which furnish steam for the Exposition, it displays its line of cleaners. A view of the exhibit is shown herewith. At the right is shown the mechanical cleaner, while running along the railing on the left is shown the motor-driven cleaner. Water-power cleaners of different sizes are shown on the pyramid in the center, which is surmounted by an 8-in. turbine cleaner. The company claims to have made the largest turbine-driven cleaner ever built, this being 12 in. in diameter. Tube cutters and reseating machines are also shown, as well as power cleaners for boilers of the bent-tube type. This machine is shown in the back part of the photograph, between the pyramid and the desk. The cleaning head and flexible shaft are shown on the floor in front of the pyramid, and just to the left of this is shown a reseating machine, as arranged to be driven by an electric motor. The cleaners have been adopted by the managers of the different boilers, as well as by the Exposition managers for cleaning the boilers in the Steam, Gas and Fuel Building, so that anyone interested can see the machines in operation, as well as the damper regulator made by the company.



LAGONDA MANUFACTURING COMPANY'S EXHIBIT.

THE AMERICAN CONDUIT COMPANY, of Chicago, has an attractive and interesting exhibit in the court of the Palace of Electricity. The exhibit is worthy of the attention of anyone interested in underground electrical construction. It demonstrates the high class of underground construction obtained by the use of bituminized fibre conduit. A portion of the underground system with the street, the earth and the concrete filling removed to expose the ducts themselves is also shown. This portion brings out one of the advantages of the long lengths, namely, the few joints in the system and also shows the alignment secured and the sealed joints, a feature invented and introduced by this company.

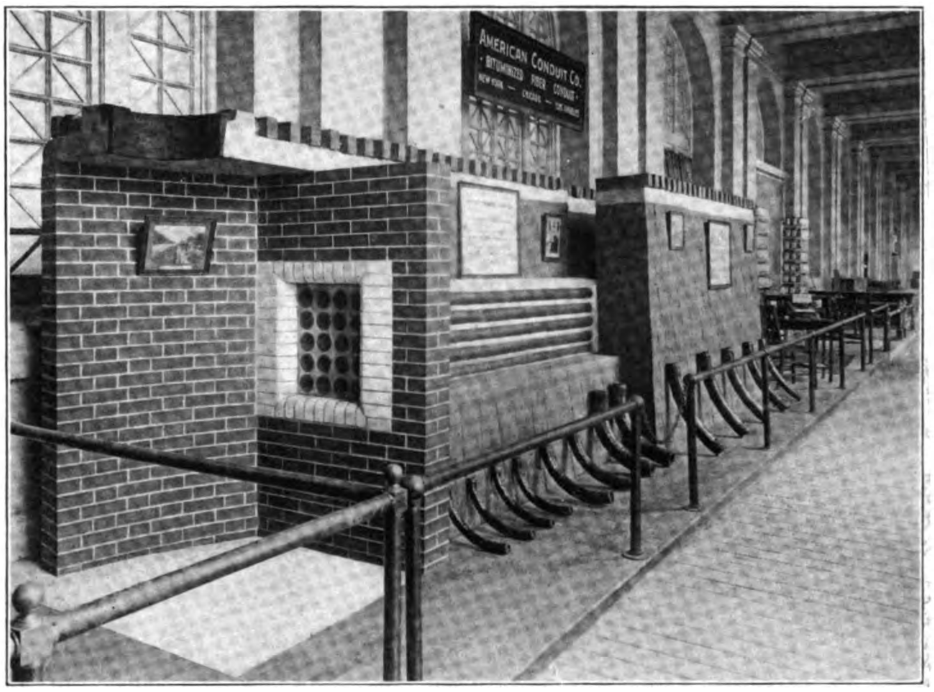


EXHIBIT OF THE AMERICAN CONDUIT COMPANY.

Another portion of the exhibit shows the open trench with the various layers of ducts as they appear in the course of actual progress of the construction work. There are, in addition to the above, some bends of various radii and diameter and some lengths of conduit. Also some interesting photographs showing construction work in various cities where bituminized fibre conduit has been used. An attractively furnished office is provided for the convenience and comfort of those who are directly or indirectly interested in electrical conduits.

THE D. & W. FUSE COMPANY, of Providence, R. I., exhibits two boards in the Western Electric Company's exhibit, showing this company's different forms of cut-out boxes. Board No. 1 displays a complete line of boxes designed to operate satisfactorily on circuits ranging from 250 to 6000 volts, and comprising the following types: Transformer cut-outs, service switches and boxes, entrance cut-outs and railway cut-outs, all equipped with enclosed cartridge fuses, the types of contacts with the fuses varying according to the conditions for which the boxes are designed, some having the well-known clamp contact where extreme vibration renders a clip fuse impracticable, while in other boxes the spring-clip fuse is used. On Board No. 2 is mounted a complete line of low-potential cut-outs of the spring-clip type, and also the type A or screw-clamp contacts. This applies also to the 500 and 2,500-volt cut-outs and fuses. In addition to the bullseye indicating cartridge fuses, several other specialties are shown, such as re-loading plug fuses and several types of panel fuses, also telephone, telegraph and fire alarm protectors.

THE LUNKENHEIMER COMPANY, of Cincinnati Ohio, has a unique exhibit in Machinery Palace, location 5-G, Block 26. It is easily identified by a large model of their valve in hand, which occupies a prominent corner of their exhibit. Pyramids of globe, angle, cross, lever and gate valves of various designs and sizes are arranged about the exhibit and agreeably offset by a black plush curtain at the side and rear. The glass cases arranged in front of the exhibit contain a smaller class of goods manufactured by the company, such as lubricators, oil and grease cups, cocks, etc., of all sizes. Neat designs of racks containing various sizes of whistles, injectors, pop valves and a variety of other specialties add to the interest of the exhibit. A new design of water gauge and oil pump for cylinder lubrication are features in themselves. Dispersed about the exhibit are pipe fittings of every description, together with whistles, safety and check valves and numerous other appliances made by the company.

OBITUARY.

P. B. CORNWALL, president of the Mutual Electric Light Company, San Francisco, died recently, aged eighty-two years. Notwithstanding his advanced age, Mr. Cornwall visited his office regularly up to within ten days of his death. A California pioneer of 1848, he was one of the few adventurous persons who gathered at Sutter's Fort prior to the discovery of gold and founded the town which afterward became Sacramento. In the earliest days of electric lighting on the Pacific Coast he became president of the California Electric Light Company, which was absorbed by the Edison Electric Light & Power Company, the latter being in turn merged into the San Francisco Gas & Electric Company. Later Mr. Cornwall, together with Mr. D. O. Mills, established the Mutual Electric Light Company. Mr. Cornwall had other extensive interests outside the electrical field. He leaves a widow and three sons.

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PERSONAL.

MR. HOMER E. NIESZ, of the Chicago Edison Company, has been appointed editor of the "Question Box" for the next convention of the National Electric Light Association. Mr. Niesz has already commenced work on the Question Box.

MR. JOHN V. REDFIELD, after some years in the works and in the Chicago sales office of the Westinghouse Electric & Mfg. Company, has been appointed to the sales staff of the Allis-Chalmers-Bullock interests at their Chicago office.

PROF. HARRY E. CLIFFORD has been appointed acting chief of the Department of Electrical Engineering at the Massachusetts Institute of Technology, succeeding Dr. Louis Duncan, who recently resigned to re-enter the engineering field.

MR. W. M. S. MILLER, who was in the employ of the Westinghouse Electric & Mfg. Company for about fourteen years, has joined the staff of the Allis-Chalmers Company with headquarters in Chicago.

MR. S. H. SHARPSTEEN, for a number of years a salesman with the General Electric Company, has accepted a similar position with the Allis-Chalmers Company, with headquarters at the New York office.

MR. E. M. GREEN has resigned the superintendency of the electric light and power plant at Rappahannock, Va., in order to accept the same position with the municipal electric light plant at Fredericksburg, Va.

MR. R. L. RICHARDSON, for a number of years in the Pittsburg sales office of the Westinghouse Electric & Mfg. Company, has become a member of the Pittsburg selling force of the Allis-Chalmers Company.

MR. JAMES ASHWORTH, until recently engineer of the City of Chicago, in the Department of Water Supply, has entered the employ of the Allis-Chalmers Company as salesman in their Pumping Engine Department.

MR. M. C. MILLER, one of the leading men in the alternating current department of the Westinghouse Electric & Mfg. Company, Pittsburg, Pa., has resigned his position with that company to accept a similar position with the Allis-Chalmers Company.

MR. G. FRED COLLINS, who has a very extensive acquaintance throughout the East among officials and engineers of large railroad and steel companies, has recently entered the employ of the Allis-Chalmers Company as special representative at the New York office.

MR. E. D. HUBBARD, who has been for several years connected with one of the prominent electrical establishments of Detroit, Mich., has been appointed general foreman of telegraph lines of the Grand Trunk Railroad system, his territory extending from Port Huron, Mich., to Chicago.

MR. CHAS F. ADAE, for several years in the employ of the Westinghouse Electric & Mfg. Company, Pittsburg, Pa., and lately manager of the Pittsburg office of the C. Lee Cook Company, has been appointed to the selling force of the Allis-Chalmers Company at the New York Office.

MR. J. DE SMET MAGUIRE has resigned his position as special representative of the National Electric Company, of Milwaukee, to accept the presidency of the American Electric Controller Company, of New York. Mr. Maguire's headquarters will be at his company's New York offices, No. 12 Dey Street.

MR. W. S. BARSTOW, the well-known consulting engineer and former manager of the Brooklyn Edison Company, has been elected a member of the faculty of the Brooklyn Polytechnic Institute. Mr. Barstow will serve in the Department of Electrical Engineering as consulting professor of central station practice.

MR. OTTO CLYDE ROSS, for several years employed with the Westinghouse Machine Company as engineer and salesman, and lately in the employ of the Hartford Lead, Zinc, Mining & Smelting Company as engineer, has accepted an appointment with the Allis-Chalmers Company as engineer and salesman.

MR. JOHN HUMISTON, now superintendent of underground construction and line distribution with the Chicago Telephone Company, will soon sever his connection with that company to join forces with the firm of McMeen & Miller, the well-known telephone engineers. Mr. Humiston is a Western man, educated at Lake Forest University, near Chicago, and at the Armour Institute of Technology, Chicago. He has been engaged with the Chicago Telephone Company for the past eight years, since leaving Armour Institute. In vacations during his college work, he had practical training with the Metropolitan West Side Elevated Railway and the Bankers' Electric Protective Company of Chicago. Mr. Humiston is particularly well versed in the very important work of telephone construction. In this his education has been largely in the "school of hard knocks," as Mr. George A. Damon calls it. This schooling, following the excellent training gained in college, has developed a capacity for "doing things" which is a valuable asset. Mr. Humiston has made an extensive study and done much practical work in the field of electrolysis of underground pipes for gas, water and electric services. His paper on this subject read before the New Orleans meeting of the National Gas Association in 1902 resulted in his being consulted in many cases where this problem had to be solved. He is consulting engineer for a dozen or more gas and electric companies, whose underground construction requires preventive and corrective work to be done. McMeen & Miller are undertaking the work, as electrical engineers, of the entire construction of the new independent telephone system in Quincy, Ill., and Mr. Humiston will be actively connected with that project.

JOHN HUMISTON.

MR. WILBUR M. RUTH, an engineer of wide experience in both steam and electrical work and until recently assistant to the president of the Mesta Machine Company, Pittsburg, Pa., and previously employed on the engineering staff of the E. P. Allis Company, has accepted a position as salesman and engineer for the Allis-Chalmers Company at the Pittsburg office.

MR. F. A. SCHEFFLER, who has for some time occupied a very important position on the engineering staff of the Marine Engine & Machine Company, recently resigned his position with that company in order to become a special representative of The Stirling Company, manufacturer of the well-known Stirling boiler. Mr. Scheffler's headquarters will be at the New York office of the company, 114 Liberty Street.

DR. F. A. C. PERRINE, former president of the Stanley Electric Manufacturing Company and sometime professor of electrical engineering in the Leland Stanford, Jr., University, has become a member of the faculty of the Brooklyn Polytechnic Institute. Dr. Perrine will affiliate with the Department of Electrical Engineering as consulting professor in long distance electric power transmission. Dr. Perrine is thoroughly conversant with this branch of electrical engineering and his long experience as chief engineer of the Standard Electric Company, of California, which company operates one of the longest electric transmission lines in the world, especially fits him for the position.

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TRADE PUBLICATIONS.

PANEL BOARDS. The H. O. S. Engineering Company, New York.—This is bulletin No. 42, containing illustrations and price lists of H. O. S. all-copper panel boards, cabinets, etc.

SINGLE-PHASE ALTERNATING-CURRENT MOTORS. Wagner Electric Manufacturing Company, St. Louis, Mo.—Bulletin No. 68, superseding bulletin No. 66 and devoted to the well-known Wagner single-phase motor.

CONDENSING MACHINERY. Dean Brothers Steam Works, Indianapolis, Ind.—A catalogue of convenient size, containing illustrated descriptions of Dean air pumps, condensers and combination outfits for all classes of condensing plants.

PANEL BOARDS AND CABINETS. The F. Bissell Company, Toledo, Ohio.—Bulletin No. 20, being a revised edition of the former bulletin of that number and containing illustrations and prices of a large line of panel boards and panel board cabinets.

MERCURY VAPOR ELECTRIC LAMPS. Cooper Hewitt Electric Company, New York.—This is bulletin No. 5, containing illustrations of the several types of mercury vapor lamp built by this company and a presentation of the merits of the lamp.

HORIZONTAL EDGEWISE SWITCHBOARD INSTRUMENTS. General Electric Company.—Bulletin No. 4384, devoted to the voltmeters, ammeters, wattmeters, frequency indicators and power factor indicators of the horizontal edgewise type for switchboard service.

SINGLE-PHASE INDUCTION MOTORS. Stanley Electric Manufacturing Company, Pittsfield, Mass.—Bulletin No. 142, containing an illustrated description of a line of self-starting single-phase induction motors in connection with which condensers are used for starting.

TELEPHONE SWITCHBOARDS AND APPLIANCES. The Vought-Berger Company, La Crosse, Wis.—A collection of leaves in a loose-leaf binder, each leaf bearing a well executed engraving illustrating some member of the extensive line of telephone apparatus built by this company.

STORAGE BATTERY DATA AND MEMO BOOK. Electric Storage Battery Company, Philadelphia.—A pocket size booklet bound in flexible celluloid and containing some extremely useful information concerning storage batteries in general and the "Chloride" accumulator in particular.

POP SAFETY VALVES AND OTHER BOILER FITTINGS.—Crane Company, Chicago.—This is special catalogue No. 100, containing illustrated descriptions and price lists of the well-known Crane pop safety valves, and also of Crane blow-off valves, ball and lever safety valves, steam gauges, water gauges, and other boiler fittings.

RHEOSTATS, MOTOR STARTERS, ETC. Cutler-Hammer Manufacturing Company, Milwaukee.—This is a hanger 38x50 inches, containing illustrations of the principal standard apparatus and some of the special appliances built by the Cutler-Hammer Company. The various illustrations are identified by the numbers of the bulletins in which the descriptions and prices may be found.

KINSMAN REFLECTORS. McLeod, Ward & Company, New York.—A pocket size catalogue, containing illustrated descriptions with prices of the Kinsman desk, portable, piano and other reflector fixtures for incandescent lamps. A new fixture, known at No. 18-A, has been added to the line in order to meet the demand for a desk reflector of somewhat lower cost than the well-known No. 1 fixture.

DIRECT-CURRENT MOTORS FOR PRINTING PRESSES. Sprague Electric Company, New York.—Bulletin No. 221 devoted to motors and controlling apparatus for printing press and similar service. The pamphlet is handsomely executed and contains illustrations of the various types of motor and controller built by the Sprague Company, as well as illustrations of notable printing press, linotype and other equipments.

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BUSINESS NEWS.

HAMMACHER, SCHEMMER & COMPANY, New York, have removed to their new building at Fourth Avenue and 13th Street.

WILLIAM A. CORRAO & COMPANY, St. Louis, report a brisk trade with their Guthrie sign flasher, which is said to be an extremely simple and reliable device.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, has received a Grand Prize for its telephone systems and apparatus, displayed at the Louisiana Purchase Exposition.

RENE LIONAIS has engaged in electrical contracting, with headquarters at 904 St. Urbain St., Montreal. Mr. Lionais was for ten years with Collyer G Brock, a well-known electrical contractor in Montreal.

THE LAGONDA MANUFACTURING COMPAY, Springfield, Ohio, maker of Weinland tube cleaners, announces that it has been awarded the gold medal for boiler tube cleaners by the Jury of Awards of the St. Louis Exposition.

THE ELECTRIC CONTROLLER AND SUPPLY COMPANY, Cleveland, has established a Southern branch office at 509 Woodward Building, Birmingham, Ala. The company is now represented in New York, Pittsburg, Birmingham, Denver, San Francisco and London (England).

MOLINE INCANDESCENT LAMP COMPANY has opened a branch office at No. 105 Chambers Street, New York, under the management of E. E. Anderson, and a branch office in New Orleans in charge of S. J. Stewart. Other offices will be opened as rapidly as suitable representatives can be secured.

HOLOPHANE GLASS COMPANY, New York and Chicago, has purchased the interests of the V. R. Lansingh Company, Chicago, which has been for some time the Western distributor of Holophane glassware. The Chicago office will be continued under the management of Mr. V. R. Lansingh and this will be the main office of the company.

THE REEVES ENGINE COMPANY, New York and Trenton, N. J., has closed a contract for six vertical cross-compound engines to drive the lighting and power generators for the Pennsylvania Railroad Company's East River tunnel, three engines to be installed on the New York side and three on the Long Island side. During the month of September the company closed orders for thirty-six engines.

ALLIS-CHALMERS COMPANY reports that the 5000-h.p. Allis engine and Bullock generator at the St. Louis Exposition were awarded each a Grand Prize. The Allis-Chalmers exhibit in the department of mines and metallurgy was also awarded a Grand Prize. The Bullock alternators, synchronous motors and other apparatus received a Grand Prize and the Bullock system of multiple-voltage control for motors won a gold medal.

THE BALL ENGINE COMPANY, Erie, Pa., recently received an order for two 1000-h.p. horizontal cross-compound Corliss engines direct-connected to alternators for the People's Ice, Light & Storage Company, of McKeesport, Pa. The company's shipments of smaller engines show no diminution, recent orders covering some 25 engines ranging from 50 horse-power to 350 horse-power, almost all for driving electric generators.

GENERAL INCANDESCENT ARC LIGHT COMPANY, New York, recently closed a contract for a complete street lighting system at Westerly, R. I., in the face of severe competition. The company has also closed a contract for 1250 dust and airtight outlet boxes for the new Wanamaker Building at Philadelphia. The company's Ohio branch office has been removed from Cleveland to Cincinnati, with headquarters in the Perin Building.

McMEEN & MILLER (Samuel G. McMeen and Kempster B. Miller), Chicago, have been given entire charge, as electrical engineers, of the construction of an independent telephone system at Quincy, Ill. A considerable amount of underground conduits will be laid and the cable system will be planned on the broadest lines of efficiency and economy. The company recently formed to establish the system has obtained a franchise with broad privileges.

THE MARSHALL ELECTRIC MANUFACTURING COMPANY, Boston, Mass., has succeeded the Marshall-Sanders Company in the manufacture of electrical specialties. The new company will continue the business of the old one with increased financial resources and an augmented executive staff. Mr. Norman Marshall, president of the old Marshall-Sanders Company, is the president of the new concern and Mr. F. Schoenthal is the secretary and treasurer. The company's facilities will be increased as rapidly as possible.

MARINETTE GAS ENGINE COMPANY, Chicago Heights, Ill., is rapidly increasing the number of its engines in commercial operation. In Pittsburg alone the company has installed some 25 or 30 engines of 50 horse-power and over. Three of the largest daily papers in that city are printed by motors supplied from generators driven by Walrath gas engines, and a number of office buildings and apartment houses are equipped with Walrath gas engines driving lighting generators.

THE WELLMAN-SEAVER-MORGAN COMPANY, Cleveland, Ohio, has been awarded the contract for the turbine water wheel equipment of the new power house of the Chicago drainage canal. This is said to be the second largest single contract for water power equipment in the United States, the largest equipment being one built by the same company at Sault Ste. Marie, Mich., for the Michigan & Lake Superior Power Company. The equipment will comprise four 6000-h.p. units of turbine wheels direct-connected to electric generators.

CONSOLIDATED ENGINE-STOP COMPANY, New York, recently received an order from the United States Government to equip the four engines in the Philippine power plant at the World's Fair with the Monarch automatic engine stop and speed limit system. The plant consists of a Ball & Wood engine, two Shepherd engines and a Phœnix Iron Works engine, aggregating 1500 horse-power. This company has also a number of other equipments at the World's Fair, notably those on the four large vertical Westinghouse engines, the large Hamilton-Corliss engine, the Harrisburg Foundry & Machine Company's four-valve engine, and the Greenwald-Corliss engine, all in the Palace of Machinery.

THE POWER & MINING MACHINERY COMPANY, New York, has recently closed a contract with Mr. James E. Hooper, of Baltimore, for a 25x30 two-cylinder gas engine, and two No. 8 suction producers, the plant to be installed in Mr. Hooper's new cotton mill at Woodberry, Baltimore. The engine as installed will have three rope-drive pulleys for driving to the floors of the mill, and the shaft will be extended for a flanged coupling, so that another 25x30 two-cylinder engine can be installed at a later date, it being Mr. Hooper's intention to double the mill after the first half is in operation. This is said to be the first installation of gas engines for cotton mill work.

GENERAL ELECTRIC AWARDS.—The General Electric Company has been awarded five Grand Prizes, ten gold medals, five silver medals and two bronze medals by the Jury of Awards of the St. Louis Exposition. One Grand Prize was awarded for each of the following: Curtis steam turbine; alternating-current turbo-generator installation, alternating-current generator and motors, static transformers and rotary converters; direct-current generator and motors; electric railway motors and the contol systems for single and multiple unit operation and for mining and industrial locomotives; arc and incandescent lamp and arc lighting systems. A gold medal was awarded for each of the following: Complete switchboard and controlling apparatus and application of electric motors for mechanical purposes; mercury arc rectifier; wires and cables for lighting and power; electric measuring instruments; electrical laboratory apparatus; warship turret handling and controlling apparatus; sewing machine motors; best exhibit in Electrical Department; mining locomotives; social betterment of employes. Each of the following exhibits was awarded a silver medal: Sockets, switches and wiring appliances; balance light distributing concentric diffuser steel ceiling; electric searchlights; sockets, switches and wiring appliances; Lemp irreversible automobile steering check. The bronze medals were awarded as follows: One for the lumichromoscope and the other for porcelain wares.

WESTINGHOUSE AWARDS AT THE EXPOSITION.—The Westinghouse Companies are the recipients of a long list of awards from the Louisiana Purchase Exposition Jury. The list, in brief, is as follows:

Special award in the Department of Machinery for the "Best, most complete and most attractive installation."

Grand Prizes: Three to the Westinghouse Electric & Manufacturing Company, for "Alternating current generators and motors, alternating current turbo-generator installation, static transformers, and rotary converters"—Group 67; for "Direct current generators and motors"—Group 67, and for "Electric railway motors, alternating current and direct current, and control systems for single and multiple unit operation and for mining and industrial locomotives"—Group 67; one to the Westinghouse Machine Company, for "Horizontal gas engines and steam turbines"—Groups 62 and 63; one to the Westinghouse Air Brake Company, for "Air brakes and friction draft gears"—Group 74; one to the Westinghouse Traction Brake Company, for "Brakes for electric cars"—Group 74; one to the American Brake Company, for "Driver brakes"—Group 74; one to the Westinghouse Automatic Air & Steam Coupler Company, for "Air and steam couplers"—Group 74; one to the Westinghouse Brake Company, Limited, London, England, for "Air brakes and accessories"—Group 74; one to the Westinghouse Company, Limited, of St. Petersburg, Russia, for "Air brakes and accessories"—Group 74; one to the Union Switch & Signal Company, for "Signal system"—Group 74; one to the Cooper Hewitt Electric Company, for "The development of the mercury vapor arc lamp"—Group 69.

Gold Medals: Three to the Westinghouse Electric & Manufacturing Company, for "Complete switchboards and controlling apparatus, and the application of electric motors for mechanical purposes"—Group 67, for "Alternating current, direct current, and Bremer arc lamps and arc lighting systems"—Group 69, and for "Electric measuring instruments"—Group 71; one to the Nernst Lamp Company, for "Nernst lamps"—Group 69; one to the Cooper Hewitt Electric Company, for "Vapor lamps for photo-engraving"—Group 15; one to the Pittsburg Meter Company, for "Water and gas meters"—Group 64; one to the Westinghouse Electric & Manufacturing Company, for "Industrial betterment work"—Group 138, and one to the Westinghouse Electric & Manufacturing Company, for "The housing of the working classes"—Group 136.

Silver Medals: One to the Westinghouse Electric & Manufacturing Company, for "Switches, fuses and wiring appliances"—Group 69; one to the Sawyer-Man Electric Company, for "Incandescent lamps"—Group 69; one to the Bryant Electric Company, for "Electric light fittings"—Group 69, and one to the Societe Anonyme Westinghouse, Havre, France, for "Gasolene automobiles"—Group 72.

One Bronze Medal to the Perkins Electric Switch Manufacturing Company, for "Electric switches"—Group 69.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

DECATUR.—The Decatur Light, Power & Fuel Company has designated Mr. Hubert B. Johnson, of this city, as its Alabama agent to succeed Mr. E. F. Taylor.

ALASKA.

WRANGEL.—Messrs. E. H. Lyons, Harry P. Casser and L. Milligan have secured a franchise for the construction and operation of an electric light plant.

SKAGWAY.—The White's Pass & Yukon Railroad intends to install a complete modern electric plant at the shops here and will be prepared to furnish lights to the people of the city. Orders for the equipment have been placed.

ARKANSAS.

FOREMAN.—Messrs. H. M. and E. P. McIver are making arrangements to establish an electric light plant here.

SEARCY.—The estimated cost of the new electric light plant, for which bids were recently opened, is in the neighborhood of $22,000.

PINE BLUFF.—The Pine Bluff Light & Water Company recently added to its equipment another generator, which will enable the company to greatly enlarge its service.

LITTLE ROCK.—The City Council is considering the advisability of purchasing new machinery for the electric light plant. The improvements will probably cost about $9,550.

CALIFORNIA.

OAKLAND.—The contract for the erection of the new municipal light plant has been let by the City Council.

ALAMEDA.—A proposition for the enlargement of the municipal lighting plant has been presented to the Council.

CHICO.—It is reported that the Butte County Power, Light & Water Company, of this city, has secured the franchise for supplying electricity to Sterling City.

EUREKA.—President B. Von Homeyer, of the Humboldt County Light, Water & Power Company, is perfecting the plans for the plant which the company expects to erect here.

SAN FRANCISCO.—The California Gas & Electric Corporation awarded a contract to the California Electrical Works for 12,000 four-part "Thomas" insulators for operation on 60,000 volts.

CHICO.—Mr. J. A. McFeely has appropriated 12,000 inches of the water of Deer Creek, in Butte County, to be used in generating electric energy for power, irrigation and domestic purposes.

EUREKA.—It is rumored that the sale by the Humboldt Milling Company of its electric light plant to Eureka parties is the first step toward an electric road from Eureka to Rohnerville and in time to the other towns south of Rohnerville. The company will furnish lights and power for all purposes. Mr. L. M. Hancock, the electrical engineer, of San Francisco, is said to be interested in the project.

COLORADO.

SALIDA.—The Salida Light, Power & Utility Company has been incorporated with a capital stock of $50,000.

LAS ANIMAS.—The following are the present officers of the Las Animas Electric Company: President, P. C. Scott; vice-president, W. A. Otis, of Colorado Springs; secretary, George B. Tripp, Colorado Springs; treasurer, J. W. Sargent, Colorado Springs; manager and purchasing agent, George M. Hoag.

DENVER.—The Denver Gas & Electric Company recently increased its equipment by installing a 3500-h.p. engine capable of supplying current for 45,000 16-c.p. incandescent lights. With the addition of this new unit the company expects to be able to meet all the demands for light for several years to come.

SALIDA.—A chart of preliminary plans and specifications for a water power electric plant is now in the hands of the Edison Electric Light Company, and as soon as a site for the plant can be determined upon work will be commenced. The present plan is to install a plant with a producing capacity of 2000 horse-power.

CONNECTICUT.

NORWALK.—One of the most successful electric light and power plants is the South Norwalk. It is claimed that power is furnished by this plant at half the cost at which it can be obtained in any other city in Connecticut, and that this is the principal inducement that has caused half a dozen new industries to locate here during the past two years, while it has prevented other concerns already established from moving to other points. The plant is municipal in name only, being handled independently, although the city is lighted at actual cost. Its general superintendent, A. E. Winchester, is to be congratulated on his able management. An immediate increase of the plant's capacity is contemplated.

DELAWARE.

WILMINGTON.—The National Lighting Company, with a capital of $500,000, has been incorporated.

FLORIDA.

GRACEVILLE.—Robert Boone, of Marianna, is said to have secured a franchise for establishing water works and an electric light plant.

GEORGIA.

ATLANTA.—Mr. A. Balsley has succeeded J. N. Eley as chief electrician of the Georgia Railway & Electric Company of this city.

GREENSBORO.—An election will be held here November 9 for the purpose of voting on the proposition to install an electric light plant.

WAYNESBORO.—The contract has been let for the new electric lights in Waynesboro and it is expected to have them ready for use by the first of January next.

HARTWELL.—The new electric light plant for Hartwell is being pushed to completion as rapidly as possible, and it is hoped to have it in operation in a few weeks.

BROXTON.—A. G. Garbutt has secured a franchise for the erection of an electric light plant. The plant is to be in operation by the end of this year and the town will be furnished with lights at $70 per year.

ELBERTON.—The plans have been perfected for the proposed electric power plant to be established on the Savannah River near this place. The power will be transmitted to cities in South Carolina. The plant will develop 7000 horse-power.

LA GRANGE.—The citizens of La Grange recently voted for the issue of bonds to the amount of $40,000, of which $25,000 will be expended in building and equipping an electric light plant. The City Council has had the question of municipal ownership under consideration for some time and expects to have better lighting service than by the contract system and at much less cost.

IDAHO.

COEUR D'ALENE.—Mr. B. F. Kelly is manager of the Consumers' Company, of this place.

TROY.—The City Council has granted to the Troy Manufacturing Company a franchise for an electric light plant which will furnish lights for the town.

BOISE.—The engineers for the Highland Power Company are said to have perfected plans for the restoration of the plant at Boise. The power house will be built on the north side of the river.

NEZ PERCE.—The Nez Perce Water & Power Association has purchased the Nez Perce Electric Light Plant, the creamery plant, the flour mill and the Lolo Power Company's plant and will also take over the water works system of the town. A new water plant will be installed immediately. The capital stock of the new company is $100,000 and the incorporators are Z. A. Johnson, Stephen Johnson, C. W. Lewis, J. L. Harris and T. W. Englehorn.

LEWISTON.—Reports are to the effect that the Lewiston Water & Power Company, which has been engaged in building the new transmission lines to Uniontown, Genesee, Moscow and Pullman, is to be combined with the Lewiston Light Company, Ltd., the Clarkston Water Works and other interests to form a new company to be known as the Lewiston-Clarkston Company. The total capital will be increased to $3,000,000 in order to provide for the 1000-h.p. auxiliary steam plant now building, the extension of lines 40 miles to various mines and factories, besides the four towns already mentioned, the rebuilding of the water conduits for supplying power plants and for irrigation purposes, and increasing the capacity of the company's hydraulic-electric power plants to 5000 horse-power.

ILLINOIS.

BENTON.—The municipal lighting plant of this city was recently destroyed by fire, the consequent loss being estimated at about $10,000.

ELIZABETH.—Mr. Howard Cook, of Chicago, has secured from the Village Council a franchise to erect and maintain an electric light plant.

LITCHFIELD.—A franchise has been granted by the City Council to Charles Munday, Jr., for the construction and maintenance of electric light and gas systems in this city.

LAGRANGE.—The Lagrange Service Company, Inc., recently filed articles of incorporation. The company is capitalized at $100,000. H. J. Dunbaugh and G. C. Madison are named among the directors.

COMPTON.—The Compton Electric Light Company has filed articles of incorporation, stating the capital stock to be $25,000 and naming the following directors: J. S. Richardson, L. W. Kutter and W. N. Hills.

MONMOUTH.—The Monmouth Gas & Electric Company has filed articles of incorporation. The company is capitalized at $200,000 and proposes to operate heat, light and power plants. W. A. Thompson, Charles B. Wood and Horace S. Oakley are the incorporators.

INDIANA.

PORTLAND.—It has been decided by the City Council to install an electric light plant.

DILLSBORO.—William E. Swarthout has filed a petition for a franchise granting him the privilege of building and operating an electric light plant.

FORT WAYNE.—The work of reconstructing the city lighting plant is well under way, and the extent of the alterations promises a greatly improved lighting service when completed.

KENDALLVILLE.—The city is making arrangements to expend $4550 in new electric street lighting equipment. Twenty-five new arc lights will be added, bringing the total number up to eighty.

WEST MUNCIE.—Reports state that a stock company, headed by Jerome Herff, of Peru, has been formed for the purpose of constructing an artificial lake and dam and erecting an electric power house here.

MUNCIE.—The Muncie Electric Light Company is preparing plans for the erection of an addition to its plant in North Walnut Street. The improvements, including the equipment, will probably cost about $35,000.

NEW ALBANY.—Recent reports are to the effect that the stockholders of the United Gas & Electric Company have decided to issue $750,000 bonds for the extension and improvement of its plants in this city and Jeffersonville, as well as those located elsewhere. Orders for two 500-kw. Curtis steam turbines have already been placed.

IOWA.

LA BELLE.—It is proposed to issue bonds to provide for the completion of the electric light plant.

BURLINGTON JUNCTION.—An effort is being made to establish an electric lighting plant at this place.

EARLHAM.—According to recent reports, Hill & Johnson contemplate constructing an electric light plant.

STONE CITY.—Mr. H. F. Dearborn is said to be interested in the electric light plant being established here.

HAWARDEN.—The contract for the proposed repairs and improvements to the electric light plant has been awarded to Edwin C. Bennett & Co., of Omaha, Neb., for $4,465.

SUMNER.—A twenty-year franchise is said to have been granted by the Council to a Minneapolis firm permitting them to operate an electric light and power plant in this city.

DES MOINES.—Reports state that the Iowa Light, Heat & Power Company contemplates expending about $250,000 in improving and extending its service within the next year.

OELWEIN.—The People's Light, Heat & Power Company, Inc., has been incorporated by M. E. Springer, T. H. J. Lochband and others. The company's capital stock is fixed at $75,000.

GRINNELL.—At a recent meeting of the Commercial Exchange, O. K. Cole, of Cincinnati, who, with his brother, H. Cole, and C. W. Lawrence, of Chicago, recently purchased the entire stock of the Grinnell Heating & Electric Company, outlined the plans for improvements which the company expects to carry out. Three new boilers have already been purchased and are on their way here. This will double the present capacity of the company's boilers, increasing it 450 horse-power. The boilers will all be reset and rearranged to economize space and power and the new ones will be placed in a new boiler house now being erected just back of the old plant, and which is to be thirty by sixty feet. It will have an immense smokestack five feet in diameter and 120 feet high, with a capacity of 550 horse-power. All the street mains will be overhauled and the size of the pipes increased from eight to ten inches.

KANSAS.

KANSAS CITY.—The electric light plant here has been destroyed by fire.

LINDSBORG.—A proposition is being considered by the City Council to light the town by electricity.

WINFIELD.—Winfield is to have an electric light plant and bids have been called for for furnishing the necessary material and for constructing the power house.

CLYDE.—Preparations are being made by M. E. Maggart, of Chicago, for the erection of an electric light plant in this town. Work will be commenced about November 15.

WICHITA.—The Citizens' Electric Heat, Light & Power Company has petitioned the Council for a franchise granting the use of the streets for the purpose of installing a system of electric lights.

TOPEKA.—The Edison Electric Illuminating Company, of this city, has filed a petition with the Council for a thirty-year renewal of its present franchise, which expires January 26, 1906. The matter is under advisement by the Council.

ARKANSAS CITY.—The plant of the Arkansas City Gas & Electric Light Company has been destroyed by fire, entailing a loss of $50,000, of which $3000 is covered by insurance. The plant is outside the fire limit and has no protection. This is the second time it has burned, the first fire occurring about four years ago, after which it was immediately rebuilt.

KENTUCKY.

OWENSBORO.—Work upon the foundation for the addition to the electric light plant is under way.

WEBSTER.—The Sebree Light & Power Company has been incorporated with a capital of $10,000.

PIKEVILLE.—The Pikeville Electric Light Company has recently installed a $10,000 power plant which is now in operation.

FLEMINGSBURG.—Messrs. Henderson & O'Bannon, proprietors of the electric light plant of this place, contemplate the addition of a new dynamo to their plant equipment this fall.

LOUISIANA.

CROWLEY.—The city has purchased a new engine at a cost of $35,000, to be installed in the municipal lighting plant.

MAINE.

BIDDEFORD.—The York Light & Heat Company states that arrangements are under way for installing a 75-kw. generator direct-connected to a 100-h.p. engine. Mr. Walter Stackpole is chief engineer.

BANGOR.—A. R. Gould, of Presque Isle, writes that contracts will probably be let next March for the work in connection with the construction of a dam and the development of about 3000 horse-power at Aroostook Falls.

BUCKSPORT.—The Bucksport Lighting Company was recently organized for the purpose of conducting a general electric and gas lighting business in this town. The company has a capital stock of $15,000 and is officered as follows: President, Harry L. Cram, of Portland; treasurer, A. J. Desmond, of the same city.

MARYLAND.

CHESTERTOWN.—The business men of this city are reported to be organizing a company for the purpose of installing and operating an electric light plant.

BALTIMORE.—The Baltimore Electric Power Company has been incorporated with a capital stock of $2,500,000. The incorporators of the new company are directors and officers of the Maryland Telphone & Telegraph Company, which was recently granted a franchise to furnish light and power service. The interests of the two companies, it is said, will be identical in the construction and operation of the proposed plant.

MASSACHUSETTS.

MANSFIELD.—Much needed improvements are to be made to the lighting service here.

WEST SPRINGFIELD.—Mr. Frank L. Worthy, of this city, is said to be interested in the construction of an electric light plant.

HOLYOKE.—The Electric Light Department is considering the expenditure of about $28,000 in improving the motive power of the electric light plant.

NEEDHAM.—Mr. William H. Burgess, president of the Charles River Power Company, states that machinery for 300 horse-power has been installed and that amount of power is now being utilized. The development of the additional 700 horse-power will not be completed for some months yet.

SPRINGFIELD.—James H. Forsythe, who has been connected with the United Electric Light Company in various capacities for the past 17 years, and who for the past 12 years has been superintendent of construction, has resigned his position with the company, and has been succeeded by A. H. Bunker, of Boston. Mr. Bunker has already assumed his new duties as superintendent. Mr. Bunker has had a wide experience and is generally conceded to be a man of recognized fitness for the position of superintendent, having been for the past nine years superintendent of the Edison Illuminating Company of Boston. The retiring superintendent, so far as is known, has no plans for the immediate future. He has been popular with the men in his employ during his long connection with the United Electric Light Company and has been with it during its great progress of growth from a small concern to one of the most powerful corporations in the city. The work of underground construction for the company will hereafter be in charge of W. A. Dennett, who has been with the company for some time.

MICHIGAN.

WAYNE.—Bonds to the amount of $8000 are to be issued for the establishment of an electric lighting plant in the town.

ADRIAN.—The Citizens' Light & Power Company is contemplating installing soon a new 250-h.p. boiler and a three-phase generator.

PORTLAND.—Mr. S. E. Jarvis is reported to be negotiating for a piece of property here upon which he intends to erect a large power house at an estimated cost of $180,000.

MILLERSBURG.—The citizens of Millersburg are desirous of having the town lighted by electricity, and it is possible that the Onaway Electric Lighting Company may extend its lines to this place for that purpose.

SPRING LAKE.—At a special election held recently it was voted to install an electric light system, the current to be supplied by the Grand Rapids, Grand Haven & Muskegon Interurban Company through a meter, so that the village will pay only for the amount consumed.

MANISTIQUE.—Plans have been completed for the new plant of the Manistique Light & Power Company and the contract for the construction work has been awarded to McArthur Brothers & Co., of Chicago. It is proposed to expend about $50,000 in building and equipping the plant.

KALAMAZOO.—The Kalamazoo Valley Electric Company is making preparations to build a large dam on the Kalamazoo River next spring. It will be located somewhere between Allegan and Otsego, the exact location not being known at this time. Looking toward this project, the company has asked the City Council for an extension of its franchise for a period of thirty years. The company is at present unable to meet the demands for power and it has therefore been decided to extend and enlarge the plant.

GRAND RAPIDS.—The development of the water power at Cascade by the Cascade Electric Company, composed principally of Grand Rapids capitalists, is being pushed in order that active work may be begun in the spring. It is stated that the necessary rights have been secured and arrangements completed for the construction of a large cement dam at a cost of about $20,000. It has been decided to increase the capitalization of the company from $20,000 to $150,000. Sufficient contracts for power have already been secured, it is said, to insure the success of the new enterprise.

MINNESOTA.

MINNESOTA LAKE.—It is reported that steps are being taken toward the installation of an electric light plant.

WINTHROP.—Plans are under way for the enlargement of the electric light plant and the extension of the water works.

MINNEAPOLIS.—The Pacific Power Company has been incorporated with a capital stock of $1,000,000. C. B. Darling and S. R. Mattier are named among the directors.

MISSISSIPPI.

JACKSON.—Mr. J. B. Smith was elected city electrician at the last meeting of the Board of Aldermen.

EUROPA.—Reports are to the effect that private parties are making arrangements to install an electric light system here.

NEW ALBANY.—The plans and specifications have been prepared for a $20,000 water and electric light plant, for which bonds to that amount were recently issued.

GREENWOOD.—It is reported that bonds to the amount of $123,000 have been sold, the proceeds to be used to pay for the plant of the Water, Sewerage & Electric Light Company.

UTICA.—At an election held recently the citizens expressed themselves as being in favor of a bond issue of $19,000 to provide for the establishment of water works and an electric light plant.

ABERDEEN.—The City Council has ratified the purchase of the E. M. & J. K. Jones electric light plant, and the property has been turned over to the city. The plant will probably be greatly improved and enlarged within the course of the next year. Mr. E. M. Jones is superintendent and general manager.

MISSOURI.

SEDALIA.—Reports state that it is probable that Sedalia will shortly be lighted by electricity; the proposition to establish such a plant is now under consideration by the Council.

JEFFERSON CITY.—The plant of the Jefferson City Light, Heat & Power Company was recently sold to J. N. Horner, representing a Chicago syndicate. The transfer was accomplished in consideration of $80,000.

MONTANA.

LIVINGSTON.—G. H. Hill, of Helena, has applied to the City Council for a franchise permitting him to establish a water, light and power plant here.

NEBRASKA.

OMAHA.—The Omaha Electric Light & Power Company contemplates installing shortly a 1500-kw. Curtis turbine.

GENEVA.—Gregory F. Shinkle has been granted a franchise to establish and operate an electric light plant at Geneva.

LINCOLN.—Plans have been prepared for the new municipal lighting plant here, which will be capable of supplying 450 lights, although but 328 are to be installed at present.

KEARNEY.—The Northwestern Electric Heat & Power Company has under consideration plans for extensive improvements to its equipment; these are said to include new boilers, dynamos and transformers.

NEW HAMPSHIRE.

NASHUA.—The Rockingham Light & Power Company has notified Secretary of State Pearson of an increase in its capital stock from $750,000 to $1,000,000.

WALPOLE.—The Fall Mountain Electric Light & Power Company has completed the work of placing the street lamps. Some changes were made in the location of lamps and the arc light on North Main Street replaced with incandescent lamps. The electric light poles from the town hall to the top of Depot Hill have been removed and the main line is located on Pleasant Street.

NEW JERSEY.

JERSEY CITY.—The Weiderbold Light Company's plant here has been wrecked by an explosion.

LAMBERTVILLE.—The Lambertville Heat, Light & Power Company is extending its lines to New Hope, Pa., in order to supply light and power to that town.

KEARNEY.—A resolution has been adopted by the City Council, instructing the lighting committee to inquire into the feasibility of installing an electric lighting system in the town, and if beyond the means of the town, to ask for bids for the illumination of the streets.

NEW MEXICO.

ALBUQUERQUE.—The Albuquerque Electric Power Company has been incorporated with a capital of $50,000, for the purpose of generating and distributing electricity. William L. Iliff, William B. Childers and Edward Allen are among the incorporators.

SANTA FE.—H. B. Holt, an attorney of Las Vegas, N. M., states that Eastern capitalists are now seeking investment in the Mesilla Valley, with a view to establishing a colony and erecting a large central electric power plant. Dr. J. R. Hawes is also interested in the project.

NEW YORK.

CLIFTON SPRINGS.—A new electric lighting system is being installed here.

UTICA.—The Utica Gas & Electric Company is contemplating improvements to its plant which will involve the expenditure of $40,000.

SLOAN.—Arrangements have been made by the Village Council with the Depew & Lancaster Light & Power Company to light the village by electricity.

OLEAN.—The Genesee Valley Power Company has been incorporated with a capital of $25,000, by W. L. Young, Emma D. Young and George Forbes.

ALEXANDRIA BAY.—The Alexandria Bay Electric Light & Power Company's plant has been destroyed by fire, entailing an estimated loss of $12,000.

NIAGARA FALLS.—The Toronto Niagara Power Company has awarded the contract for four turbines of 10,000 horse-power capacity to I. P. Morris Co., of Philadelphia.

BUFFALO.—The incorporation of the Buffalo Lighting Company is reported. The company has a $30,000 capital stock, and N. McMillan and L. E. Wesley are among the directors.

ILION.—It has been voted to issue bonds to the amount of $25,000, which will be used to pay off the present indebtedness on the electric light plant and to make improvements to the plant.

HOOSACK FALLS.—The Hoosack Falls Generating Company has been organized and incorporated by E. R. Case, W. Z. Roberts and P. Fitch. The company, which is capitalized at $25,000, will operate gas and electric generating plants.

SYRACUSE.—A certificate of the incorporation of the Syracuse Electric Company has been filed by S. J. Kelly, William H. Horton and M. J. Myers, who constitute the board of directors. The capital of the company is fixed at $20,000.

ALBANY.—The Suburban Power Company has filed articles of incorporation fixing its capital stock at $10,000. The company will distribute electricity throughout Niagara and Erie counties. Among the directors are E. A. Wickes and W. B. Rankinor.

LOCKPORT.—The Common Council has voted a franchise to the Niagara, Lockport & Ontario Power Company, granting it permission to erect poles, string wires and lay conduits in the streets for the purpose of furnishing electricity for light, heat and power.

PLATTSBURG.—The property of the Lozier Light & Power Company is said to have been purchased by George M. Cole and T. B. Cotter, of Plattsburg, and H. L. Merry, of New York, and a new company has been formed with T. B. Cotter as president. The contract with H. A. Lozier for lighting the streets of Plattsburg has been transferred to the new company.

NEW YORK.—Preliminary plans have been filed for the new power station to be built for the New York Edison Company on First Avenue from Thirty-ninth to Fortieth Streets. It will be three and five stories high, with a facade of granite and brick and will have a frontage of 197 feet and a depth of 347 feet. Its cost is estimated at $1,200,000. The Allis-Chalmers Company, it is said, will furnish the equipment for the plant.

CLINTON.—The citizens have voted for a bond issue of $7000 to be used in acquiring or establishing an electric light plant. Whether the present plant will be purchased, however, or a new plant installed has not yet been decided, but it is believed that the former plan will be adopted as the necessary repairs could be made and the system put in complete running order in much less time than it would take to install an entire new plant.

GLOVERSVILLE.—Mr. J. W. Fletcher is superintendent of the electrical department of the Fulton County Gas & Electric Company, which has absorbed the Gloversville Electric Light Company and the Johnstown Electric Light & Power Company. The city contract includes 245 arc lights at $86.40 per year and 21 32-c.p. incandescent lights at $45 per year, in addition to which the company also supplies 344 commercial arc lights and 11,000 commercial incandescent lights at 10 cents per kilowatt each.

ALBANY.—The Central Power Manufacturing Company, incorporated some months ago, is negotiating for the purchase of water privileges at Cossayuna Creek, near Granville. The water power at this point is now controlled by the Alexander Blanket Company, and it is understood that the power, if obtained, will be used in conjunction with the plant to be erected near Schenectady. The stream develops about 100 horse-power when the water is at normal height, and many times that during the rainy season. The company, which is headed by Charles R. Huntley, will, it is reported, maintain a plant between Schenectady and Albany, with the end in view of supplying the current for the new barge canal, besides furnishing power for manufacturing purposes.

ONEIDA.—Considerable inconvenience was caused here recently by the breaking of the main shaft in a 500-h.p. engine in the power house of the Madison County Gas & Electric Company. It took nearly two weeks to make and install the new shaft, during which time as sufficient power could not be generated to run the trolley line and the street lights patrons of the trolley line were compelled to walk in the evening. It is now proposed to develop the power at Lime Kiln Falls, about nine miles north of this city, and establish a water power plant for the generation of electricity for commercial and lighting purposes. New York and Philadelphia capitalists are said to be interested in the project and plans have been prepared for a plant of sufficient capacity to supply Madison and parts of Oneida and Onondaga counties with electricity.

SYRACUSE.—At the annual meeting of the stockholders of the Syracuse Lighting Company held recently, considerable important business was transacted, including the election of directors, the authorizing of the placing of an order for a new battery of boilers at the electric light plant to cost $25,000, the adoption of a resolution calling a special meeting of stockholders to authorize an increase in the number of directors from thirteen to fifteen, and the presentation of the annual report of the vice-president and treasurer. The directors chosen were: Robert C. Pruyn, of Albany; Stephen Peabody, Henry Seligman and James C. Bishop, of New York; Charles Andrews, Horace White, Hendrick S. Holden, Ceylon H. Lewis, Albert K. Hiscock, John Dunfee, John J. Cummins and Louis L. Waters. At a subsequent meeting of the directors the following officers were elected: President, Ceylon H. Lewis; vice-president and treasurer, John J. Cummins; secretary, Louis L. Waters; attorney, Senator Horace White; executive committee, Ceylon H. Lewis, Robert C. Pruyn, Stephen Peabody, Henry Seligman, Albert K. Hiscock and John Dunfee.

NORTH CAROLINA.

RALEIGH.—Mr. D. A. Scanlon is superintendent of the railway department of the Raleigh Electric Company.

LEXINGTON.—Bids have been called for the construction of an electric light plant for the town, the equipment to include two 85-h.p. engines and two 60-kw. alternating-current generators.

NORTH DAKOTA.

FARGO.—Bids have been called for for lighting the streets, public buildings and places for a period of one year.

WALHALLA.—Extensions are being made to the electric light plant here, which will considerably improve the service.

WILLISTON.—An application for a franchise has been made to the Town Council, for the privilege of establishing an electric light system in Williston.

OHIO.

SIDNEY.—The Sidney Electric Light Company is making arrangements to change over to a series alternating-current arc system.

MIDDLETOWN.—The Board of Public Service is advertising for bids for the contract for lighting the streets of Middletown.

EAST PALESTINE.—The Council has decided to issue bonds to the amount of $9000 to be expended in improvements to the local lighting plant.

NEWARK.—Augustus H. Heisey, George M. Heisey, E. W. Heisey and others have filed articles of incorporation for the Newark Heating & Lighting Company, capitalized at $1,000.

SPRINGFIELD.—It is reported that the American Railways Company, which controls the Springfield Railway and the Springfield Light & Power Company, has decided to rebuild the electric light plant next year at a cost of $100,000.

BELLEVUE.—Reports state that a franchise has been granted for the construction of an electric generating plant and distributing system, with the privilege of manufacturing and selling electricity for heat, light and power purposes for private and public use. The new plant is being installed.

SIDNEY.—The Sidney Light, Heat & Power Company, recently incorporated, will probably be in the market soon for equipment for its plant. This will include two 200-kw., three-phase, belted generators, simple Corliss engine and return tubular boilers. The plans for the equipment, however, have not yet been completed definitely.

URBANA.—Mr. Pope, of the Columbus, London & Springfield Electric Railway Company, and representing the Appleyard interests, is reported to have been here recently conferring with James McCroskey, superintendent of the electric light plant, and examining the plant relative to making report to headquarters in Columbus. It is proposed to either improve the present plant or construct an entirely new one.

CINCINNATI.—A resolution was passed by the Council recently to discontinue the lighting of Bond Hill by naphtha lamps and to substitute electric lights on January 1, 1905. The naphtha lighting has been done by the Welsbach Street Lighting Company of America, and the Board of Public Service was directed to give it 60 days' notice to stop on January 1, when the Cincinnati Gas & Electric Company will begin illuminating the place with overhead electric lights at $60 apiece under its contract for lighting the streets of Cincinnati.

OKLAHOMA TERRITORY.

ANADARKO.—The Anadarko Ice Plant Company has submitted to the City Council a proposition to establish an electric light and power plant in this city.

STROUD.—A franchise has been granted by the City Council to J. L. Sales & Co., of Dallas, Tex., to establish an electric light plant. The same company has also made a proposition to establish a water works system at Stroud.

ENID.—The Enid Electric & Gas Company has been incorporated, with a capital of $200,000, by L. D. Turner and R. D. W. Holder, of Belleville, Ill.; W. N. Horner, of Chicago, and John C. Moore and Clarence E. Rentchler, of Enid.

OREGON.

NORTH POWDER.—Men are at work on North Powder River, preparing for the installation of an electric power plant.

MEDFORD.—The Medford electric light plant, formerly owned by R. A. Proudfoot, is now the property of the city. Mr. F. F. Loder is superintendent of the plant.

GRASS VALLEY.—It has been decided by the City Council to issue $10,000 bonds for the purchase and improvement of the electric light and water plant at this city.

ENTERPRISE.—The electric light plant here which was destroyed by fire some time ago, has been sold to E. J. Forsythe, who will rebuild the plant on a much larger scale.

PORTLAND.—Reports are to the effect that H. L. Vors, a capitalist of New York City, has secured an option on the property of the Hood River Electric Light, Water & Power Company, with a view to purchasing.

HAINES.—John F. O'Bryant, of Baker City, Ore., has made application to the City Council for a franchise to supply this city with power for electric lights and other purposes for a period of twenty years. The proposition is under consideration.

WESTON.—Robert Jamieson, secretary of the Umatilla Electric Power Company, writes that work will probably be commenced in the spring preparatory to developing 1500 horse-power on the north fork of the Umatilla River. The plant when completed will probably have cost $100,000.

ECHO.—The Echo River Light & Power Company has filed articles of incorporation with a capital stock of $10,000. It is the purpose of the company to construct a reservoir and use water from the Umatilla River for the generation of power. An electric light plant will be installed and equipped with two engines and a 500-light dynamo.

PORTLAND.—The Mount Hood Electric Company, recently incorporated with $1,000,000 capital stock, expects to supply the city with considerably more current than is at present available. The electricity is to be generated from the Sandy River near Mount Hood and about 25 miles from Portland. Men are already at work. Mr. Edwin D. Whitney, of Chicago, who is interested to a large extent in the project, states that 30,000 horsepower will be delivered in Portland. G. W. Waterbury and C. W. Miller are the Portland incorporators.

HOOD RIVER.—Leslie Butler, H. F. Davidson and John Leland Henderson, a company of local capitalists, are reported to have secured a lease of ground from Dr. T. L. Eliot and will erect a 50-ft. dam on Hood River about half a mile from the city. The dam will be used to hold logs for the Oregon Lumber Company and the water power developed will be utilized in operating an extensive electric plant. It is hoped to have the dam completed early in December. The company expects to furnish current for lighting and power purposes in the city, preferring, it is said, to dispose of the power at a lower rate here than to secure a higher price for transmitting it to Portland or The Dalles.

PENNSYLVANIA.

DOYLESTOWN.—Wesley Keeler is now president of the Doylestown Electric Company.

SELINS GROVE.—Mr. C. E. Pugh has been granted a franchise to construct an electric light system here.

LANCASTER.—The Millstone Water & Power Company is said to be interested in the construction of a power plant at Lancaster.

CLEARFIELD. — The Central Pennsylvania Light & Power Company expects soon to install a new engine of 400 or 500 horse-power.

BLAIRSVILLE.—Dr. S. L. Clayett has succeeded Mr. Paul Graff as president of the Citizens' Light, Heat & Power Company of this town.

ALLEGHENY.—The contract for rebuilding and remodeling the electric light plant which was destroyed by fire, has been awarded to C. F. Knapp, of Allegheny, representing Langenheim, Cochran & Co., for $33,472.

COLUMBIA.—It is understood that the Columbia Electric Light & Power Company has secured the contract for lighting the city at $80 per arc lamp per year and 10 cents net per kilowatt for incandescent lights.

LLANERCH.—The following are the officers of the Eureka Light, Heat & Power Company; President, H. Hayes Aiken; secretary, H. F. Sieber; treasurer, C. L. Rihl; superintendent, F. C. Davis; chief electrician, C. B. Fulton.

DALLASTOWN.—The Borough of Dallastown has voted to install an up-to-date system of street lighting. Arc lights will be provided for the town and the current will be furnished by the York Haven Water & Power Company.

SHENANDOAH.—The Borough Council has awarded the contract for street lighting to the new People's Electric Light, Heat & Power Company at $63.50 per light per year for three years, the contract to take effect on January 1, 1905.

DALE.—The Dale Light, Heat & Power Company has been organized, with George E. Daniels, president, and Lincoln Messenger, secretary. The company has been granted right of way over the streets by the Borough Council. The power house will be 75 x 380 feet and will be erected on Bedford Street.

WILKESBARRE.—The plants of the Luzerne County Gas Company and the Wyoming Valley Electric Light Company are reported to have been sold to Forrest & Co. and Charles B. Miller, of Philadelphia, and J. C. White & Co., of New York, N. Y., representing Philadelphia and New York capitalists. The new company will have a capital of $1,500,000, and an authorized bond issue of $3,000,000. The plants of both the gas and electric companies will be extended and other improvements made at a cost of about $500,000.

YORK CITY.—The Light Committee has awarded the contract for the lighting of the city for the next five years to the Edison Electric Company at the rate of 13½ cents per light per night. The company's present contract with the city expires April 1, next, when the new one will go into effect. Although the new rate is an advance of 2 cents per light over the old one, it is considered reasonable, amounting to about $48.77 per lamp per year. There are 360 arc lights distributed throughout the city, all on the Edison circuit.

SOUTH CAROLINA.

WESTMINSTER.—The town is reported to be considering the installation of an electric light plant.

CLINTON.—Bonds to the amount of $25,000 are to be issued for the construction of water works and an electric light plant.

LAURENS.—The citizens have voted to issue $40,000 bonds to provide for the installation of an electric light plant and a sewerage system.

AIKEN.—The Carolina Light & Power Company, of this city, is preparing to enlarge its system and will probably install a new steam turbine set.

LANCASTER.—The City Council has granted to H. L. Millner, of Morgantown, N. C., a franchise for establishing water works and an electric light plant here.

FLORENCE.—A commission for a charter has been issued to the Light & Power Company, with a capital of $50,000. The incorporators are H. C. Case and William Maul Measey, both of Philadelphia.

SOUTH DAKOTA.

PIERRE.—The Mid-Western Electric Company has filed articles of incorporation, fixing its capital stock at $1,000,000.

TENNESSEE.

DYER.—The electric light plant, which was recently burned here, is to be rebuilt at once.

JACKSON.—An ordinance has been passed providing for the granting of a new electric lighting franchise.

MARYVILLE.—The Maryville Power Company is pushing the work on its line between Rockford and this place. Maryville will be lighted by electricity as soon as the line is completed.

DAYTON.—The plant of the Dayton Light & Power Company, recently completed at a cost of $5000, has been destroyed by fire. Mr. Stone, president of the company, writes that the plant will be rebuilt and that $6000 will be expended for electrical apparatus and engines alone.

NASHVILLE.—The Nashville Railway & Light Company has placed an order for a new 500-h.p. steam turbine-generator unit, to be installed in addition to the 1500-h.p. turbine installed not long ago. The new machine has been made necessary by the greatly increased demand for lighting service.

CHATTANOOGA.—It is reported that a power plant to supply East Chattanooga, Sherman Heights, Avondale and Arlington Heights with power and lights will be erected by the company recently formed to furnish these suburbs with water. At a recent meeting of the organizers of the company it was practically decided to enlarge the original plans to include the power plant.

TEXAS.

McKINNEY.—The City Council is considering bids for the installation of an electric lighting plant here.

CALDWELL.—The new electric light plant is in operation and is giving excellent service, which is much appreciated by the people of the town.

EL PASO.—The International Light & Power Company is making preparations to install a 750-h.p. turbine connected to a 500-kw generator.

WICHITA FALLS.—The Wichita Falls Electric Light Company has been incorporated with a capital of $15,000 for the purpose of supplying electric light and power to the town. The incorporators are I. H. Kempner, Galveston; Henry Sayles, Abilene, and R. C. Malone, of this city.

UTAH.

EUREKA.—Jackson McChrystal and Philip Clark have petitioned the Council of this city for a franchise, and, if granted, they will proceed at once with the work of installing electric lights and the construction of a street car line.

RICHFIELD.—Thomas Brown, general manager of the Richfield Electric Light & Power Company, writes that in addition to the steam plant which the company has just installed here, plans are being prepared for developing a water power owned by the company a few miles from the town.

SALT LAKE CITY.—J. J. Chambers, of New York City, is said to be projecting an extensive power plant which will be located a short distance from this city and operated by means of energy derived from the Big and Little Cottonwood streams. It is proposed to develop about 2800 horse-power which will be distributed for lighting purposes and the operation of mines.

VERMONT.

RUTLAND.—The Chittenden Power Company of this city has let to the Archbold-Brady Company, of Syracuse, N. Y., the contract for building at a cost of about $125,000 a power house in Mendon, a short distance above the city water works. The new structure will be located on East Creek and will complete the company's immense plant begun several years ago when the big Chittenden dam and long pipe line were built. The reservoir extends over 800 acres of ground. The new power house will have a capacity of about 2000 horse-power and the power will be utilized by the Rutland Street Railway Company and also for commercial purposes.

VIRGINIA.

HARRISONBURG.—The contracts for building the municipal electric light plant have been awarded and include the construction of the power house, the erection of twelve miles of transmission line and the installation of machinery at the power house.

PORTSMOUTH.—The Portsmouth Electric & Gas Company is engaged in replacing the open-arc lights now in use with arc lights of the enclosed type. Several new lights will be added and the entire system is being rewired. It has been necessary to enlarge the power house in order to accommodate the new machinery necessary to supply the increased power for the new circuit.

WASHINGTON.

CHEWELAH.—The Council has passed an ordinance granting to D. F. Strobeck franchises for the construction of water works and an electric light plant, work on the plants to commence at once.

ELLENSBURG.—The electric light company here is making extensive improvements at its plant; the 350-h.p. steam engine has been discarded and the plant will hereafter be operated by water power.

TACOMA.—Arrangements have been completed whereby the plant at Electron will supply the lines running to South Tacoma with electricity; they have heretofore been operated from the station at Fern Hill.

MONTE CHRISTO.—The electric plant of the American Smelting & Refining Company, which has been furnishing light to the town, is being moved to Everett. Cohn & Sheedy, of the Royal Hotel, are installing a 150-h.p. plant to furnish lights for the town.

SEATTLE.—The Diamond Ice Company has applied to the City Council for an amended franchise giving it permission to lay underground steam pipes, electric wires and water conduits and also to erect overhead electric wires in all that portion of the city lying about the southerly line of Madison Street.

EDMONDS.—John Hoffman, of Seattle, has petitioned the City Council for a franchise to establish an electric light plant. Members of the Council thought the city should own its own plant, but the people disapproved of that plan and at a mass meeting held for the purpose the Council was asked to grant the franchise.

SEATTLE.—Building Inspector Places has in his hands the letting of the various contracts in connection with the municipal lighting headquarters at Seventh Street and Yesler Way. The contract for the concrete work has been awarded to C. J. McCain at $2000, the fireproofing will be done by the Franklin Fireproofing Company, and Charles Hill secured the stone contract.

WEST VIRGINIA.

MOUNDSVILLE.—The Council is said to be investigating the cost of improving the electric light service.

WISCONSIN.

BARABOO.—The town is to have a new electric light plant, according to recent reports.

MERRILL.—Mr. F. W. King is now superintendent of the Merrill Railway & Lighting Company.

CAMERON.—There has been considerable discussion here of late as to the advisability of constructing an electric light plant in connection with the water works.

STEVENS POINT.—The contract for the construction of a water power plant, to furnish electricity for the lighting of the city, at a cost of $18,000, has been awarded to Adolph Green, of Green Bay.

RHINELANDER.—The Rhinelander Power Company, which is constructing a power plant at Hat Rapids, has let to the National Electric Company the contract for the electrical equipment. The contract calls for two 400-kw. generators, together with all necessary switchboards, transformers, etc. The water wheels will be furnished by the Dayton Globe Iron Works and will be arranged in two sets of four wheels each. The wheel pit will be sufficiently large to admit of another double set of wheels being installed should this become necessary.

MILWAUKEE.—Much discussion has been aroused here by the reports of the committee appointed by the Council to make a tour of investigation in order to determine the advantages or disadvantages of establishing and maintaining a municipal plant as compared with the present system of lighting the city by contract. Three of the members of the committee reported in favor of the city plant, while the other two favored a continuance of the contract system for the present, inasmuch as the city, they said, is not in position financially to install as expensive a plant as would be needed to meet the demands for light and power. The matter is under consideration.

OSHKOSH.—An important transfer was consummated here recently when the plant and property of the Oshkosh Electric Light & Power Company, valued at $215,000, was turned over to the Oshkosh Gas Light Company. By means of this transaction the latter company now controls all of the lighting interests of the city, the two plants and the equipment being valued at not less than $500,000. The service of the electric light plant includes 325 street lamps, besides commercial circuits of incandescent lamps and motors. Considerable new apparatus has been installed in the plant, including the erection of a steam turbine at a cost of $30,000 for operating the generating machinery. The Oshkosh Gas Light Company not only furnishes the city with gas, but has also an electric lighting department and has heretofore supplied electric power for commercial circuits in competition with the company whose plant has just been absorbed. Edgar Sawyer is president of the company, and his son, P. H. Sawyer, is secretary and treasurer.

WYOMING.

THERMOPOLIS.—The Thermopolis Electric Light Company has suffered a complete loss of its plant by fire.

CODY.—Advices state that a company financed by Denver and Eastern capitalists will shortly undertake the construction of an electric plant at the falls of the Government dam being built on the Shoshone River. Power will be generated for the mines and smelter at Kerwin, and the plans are said to also include the construction of an electric line to Sunlight, Kerwin and the Yellowstone National Park.

CANADA.

THAMESVILLE, ONT.—The citizens have decided to construct water works and erect an electric light plant.

NANAIMO, B. C.—The City Council is contemplating the purchase of the electric light plant at this place. Arrangements are also being made, it is said, to buy the new water power plant.

NEW WESTMINSTER, B. C.—E. J. Fader, of this city, is interested in the Harrison Lake Power Company, which proposes constructing a power plant to utilize 30,000 horse-power from Rainbow Falls.

MONTREAL.—The Shelby Company of Montreal, Ltd., is making arrangements to transmit current for lighting purposes to St. Andrew's and Carillton, in Argenteuil County. The power is being taken from the North River at Isle au Chats, west channel.

CHILLIWACK, B. C.—The Chilliwack Light & Power Company has succeeded in obtaining a franchise from the City Council and is now prepared to push the work on its power plant, which will be operated by means of water from Vedder Creek.

QUEBEC, ONT.—The Quebec Electric Company is starting work on the installation of its plant at St. Anne and Seven Falls. Water will be taken from Seven Falls at 374 feet. The two falls will develop at low water between 22,000 and 25,000 horse-power.

CORNWALL, ONT.—The machinery in the power house here is being duplicated. This will give a total of 2000 horse-power, which will be sufficient to meet the demands which will be made upon the plant when the new paper and cotton mills are in operation.

NORTH BAY, ONT.—The North Bay electric light plant, owned by John Bourke, has been sold to a syndicate of which A. F. Leggett, president of the North Bay Gas Company, is the representative. The company will now control the gas and electric lighting business of the town.

WOODSTOCK, N. B.—The Woodstock Railway, Electric Light & Power Company is constructing a wood and concrete dam about two miles from the town on the Meduxnakitt River. The dam is 420 feet from bank to bank with a 175-ft. spillway 25 feet above low water. Five hundred horse-power will be developed. Work was begun in June and the company expects to deliver power by December.

WESTMOUNT, QUE.—The Town Council has decided to establish and operate its own plant and has authorized the preparation of a by-law providing for a loan of $225,000, which will be used for the installation of a combined garbage consumption plant and electric light system. It is believed that with the plant once in successful operation light could be sold to a number of surrounding towns, as well as to a large number of property holders.

CHARLOTTESTOWN, P. E. I.—Expert electrical engineers have been engaged by the city to investigate and report upon the question of a municipal lighting station. They are now looking over the situation, and as soon as possible plans and estimates of cost for a suitable lighting and power plant will be prepared. Contracts with the local electric companies are about to expire and the Council has decided to fully consider the question of public ownership before binding the city to another long-term contract at the prices being asked at present.

MEXICO.

GUADALAJARA.—Louis Ugarte has made application for a concession to use 4500 liters of water per second from the Lerma River. The hydraulic plant will be built in the vicinity of La Piedad and will furnish that town wth electricity for both lighting and power purposes.

ROSARIO.—Guillermo Vega has obtained from the government a concession authorizing him to construct an hydraulic plant for motive power and industrial purposes. The concession covers 10,000 liters of water per second from either the Baluarte River or the Rosario River.

MONTEMORELOS, NUEVO LEON.—Van Voorhis Brothers, of Monterey, Mexico, have secured the contract for installing the electric light plant for the town. It will be a water power plant and the current generated will be delivered to the city over a 10,000-volt transmission line. The plant will have a capacity of 2000 lights and the equipment consists of Victor turbines and Crocker-Wheeler alternating-current generators.

American Electrician.

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UNDERGROUND ELECTRIC RAILWAY WORK IN PARIS.

NEW CONSTRUCTION ON THE PARIS METROPOLITAN.

BY FRANCIS PAUL.

The extensive system of subways which is now being constructed in Paris will provide the city with a vast network of lines, covering a total length of nearly 50 miles. This will afford easy access between the different parts of the city. The work of construction is now being carried on, and it is expected that the entire system will be finished within a few years. Some of the lines are now in operation and the work on others is in various stages. When completed the system will undoubtedly be the largest in Europe.

The first branch of the Metropolitan system was completed several years ago. It runs almost directly across the city from east to west, and is marked *AA* on the map. The northern section, marked *NNN* on the map, runs in a semi-circle around the northern district of the city, lying about midway between the center and the fortifications. The southern district will have a similar line, marked *SSS*, which also makes a semi-circle in this region. The two new sections join with the old at the Place de l'Etoile and the Place de la Nation.

At each of the two junction points has been erected a large underground station, or rather a series of stations, adjoining each other, seeing that the lines cross at different levels. The northern section is now complete, and trains have been running over it for some time. In the southern section the work is now being carried on, and it is expected that the tunnel and overhead structure will be finished within a few months. There are two bridges to be built over tne Seine, however, and these will delay the opening of the new line. Besides these two sections, work has already been begun on some of the other branches. Referring to the map, it will be observed that there will be no less than three transverse lines, running more or less north and south. Each of these will cross the Seine upon a special bridge.

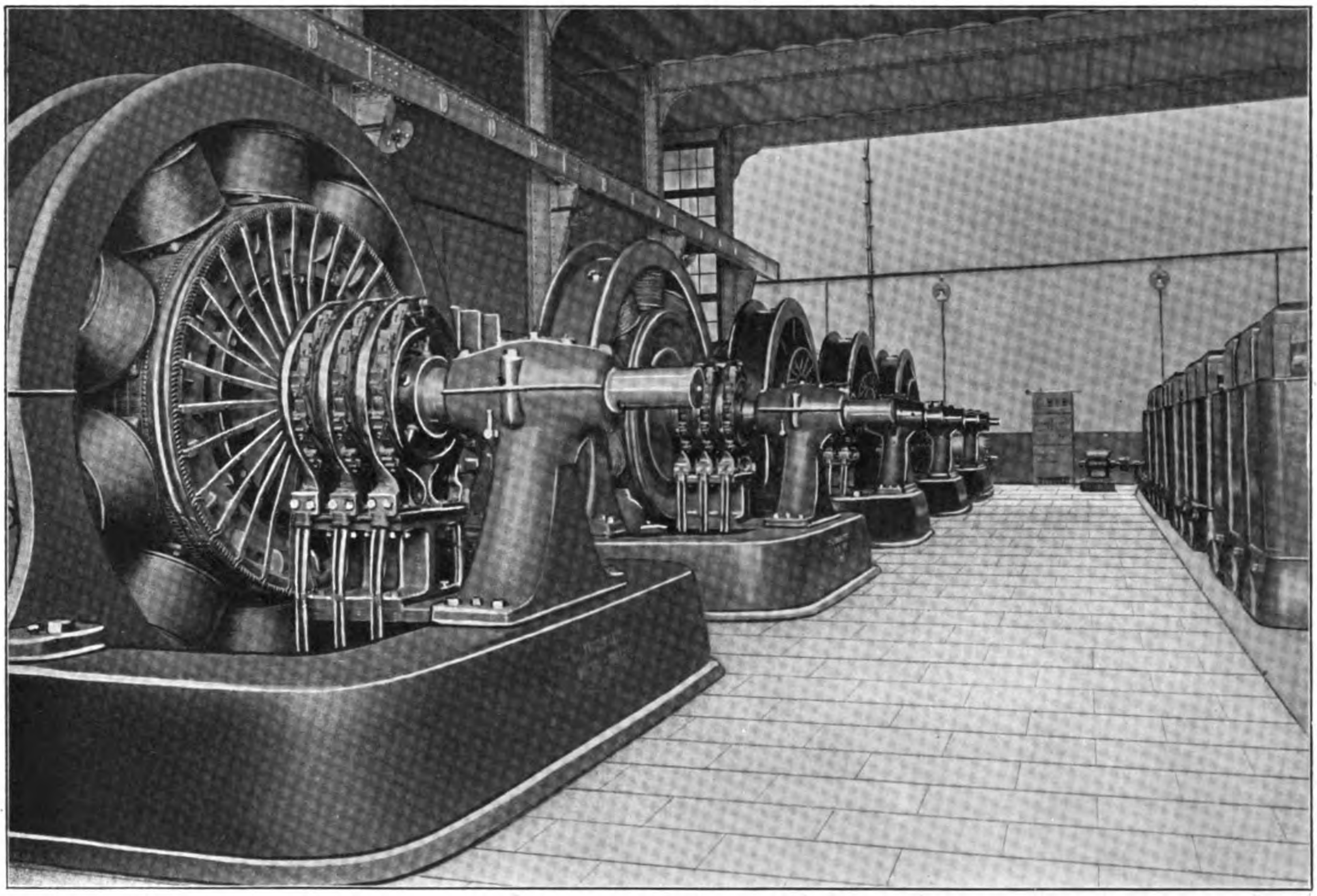

FIG. I.—NEW PÉRE LACHAISE SUB-STATION OF THE PARIS METROPOLITAN SUBWAY.

The northern section of the Metropolitan system lies partly overhead and partly underground. In general the tunnel construction has been adopted in the Metropolitan and the old section runs entirely in tunnel. The overhead construction was needed in a part of the northern section in order to pass over the tracks of two of the large railroad lines which lie in this part of the city.

The total length of the northern section is 6.1 miles, and of this about 1.2 miles are in overhead metallic structure. The latter consists of a series of bridge trusses which are mounted upon metallic columns. The structure is placed on the strip of ground which lies in the center of the Boulevards so that there is thus but little obstruction to the vehicular traffic. This line contains 23 stations; those underground are of the usual construction, having a vaulting of elliptical section with a station platform on each side of the double track.

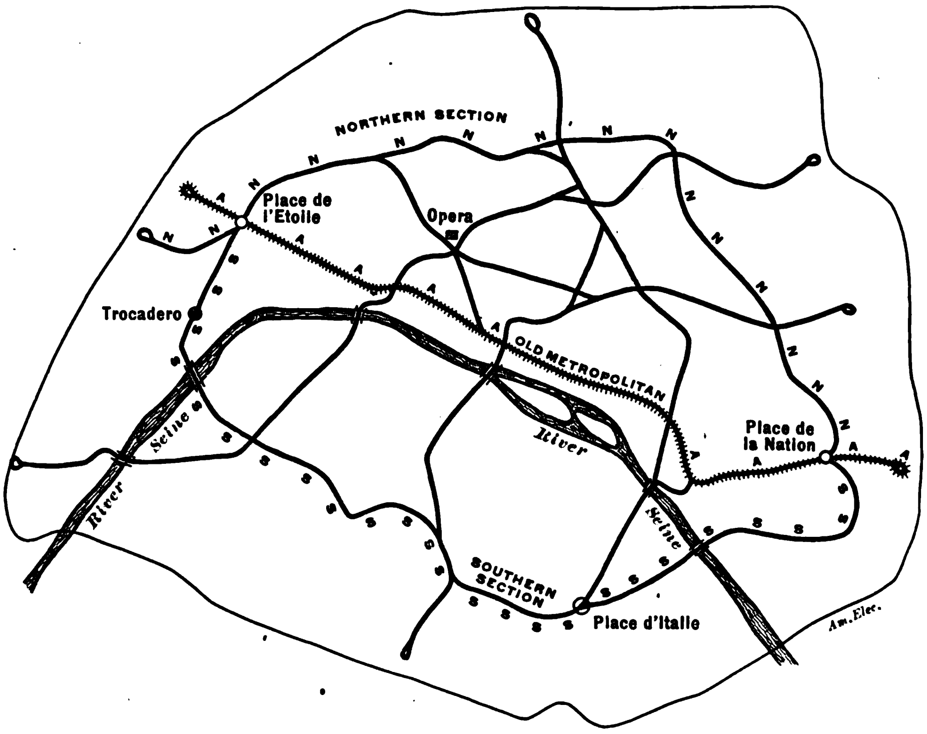

FIG. 2.—MAP OF COMPLETE AND PROPOSED SUBWAY LINES.

The construction of the underground section at the terminal points presents some unusual features. As the new line runs at a lower level than the old Metropolitan, it passes underneath it, and this makes it necessary to build the second station at a considerable depth below ground. At an intermediate point on the north line an extensive underground station has been built in order to provide for the future junction of this line with one of the newer sections, which has just been commenced. An unusual amount of underground work has been carried out at the Place de la Nation, where the north and south sections join on to the old line. The first station, that of the old Metropolitan, already existed here. It was then necessary to build a second station, lying alongside the first. The north line divides into two branches and forms a large loop which runs under the Place in a complete circle. This was required in order to facilitate the movement of the trains. Then accommodations had to be made for the southern branch, which also comes in at this point. This makes a series of underground stations which communicate with each other. Passengers descend from the street to the station on the top level, thence a set of stairways lead down to the lower stations. The whole of this extensive underground work has now been successfully carried out.

The work on the southern line presents several points of interest, first from the fact that the line lies partly in tunnel and part in overhead construction. The latter includes two overhead parts, which are joined by a section of tunnel. Besides, the line will cross the Seine at two different points near the terminal stations. This requires the construction of two bridges of special form. These are to be built in two stories, the lower for the carriage tracks and footway and the upper structure, supported on iron columns, for the tracks of the Metropolitan. One of these bridges has already been commenced and the other is to be built in the near future.

The total length of the new section between the terminals is about 8½ miles. The two parts of the overhead structure figure for 1.5 and 0.5 miles, respectively, or a total of about 2 miles. Fig. 3 gives an idea of this part of the line, showing the type of structure which has been adopted on the southern branch. The line passes along a strip of free ground in the center of the Boulevards. As will be observed, it consists of a series of metallic trusses which are upheld upon masonry pillars or in other cases upon ornamental cast-iron columns.

The lower part of the metallic structure is placed at 5.20 meters above the street level, which is the minimum distance which can be used. The grades on this part of the road do not exceed 4 per cent., except at the steep parts, where the line descends into the tunnel. The trusses have varying lengths, the maximum is 44 meters, which is used in a few cases for crossing some wide streets. In most cases the length is 27 or 22.5 meters. There are 18 stations on the southern line, with an average of 498 meters between stations. At one point on the line is a large underground station, which provides for the future junction of one of the transverse lines. The largest underground construction lies under the Place d'Italie, where there are two stations lying side by side. The second of these forms the terminus of another transverse line. Access is given between the two by a series of arches in the masonry. Of the 18 stations on the section, 6 are placed on the overhead structure and 3 are nearly flush with the ground. In the remainder the usual form of underground station has been adopted.

The new bridge, which is now being built over the Seine, will be constructed in two parts, with the middle resting upon a small island. The first part will be 114 meters between abutments and the second branch will be 90 meters long. The bridge will support an upper structure 7.3 meters wide upon iron columns to provide for the double tracks of the Metropolitan. Counting the metallic approaches on each side, the total length of the bridge will be about 400 meters.

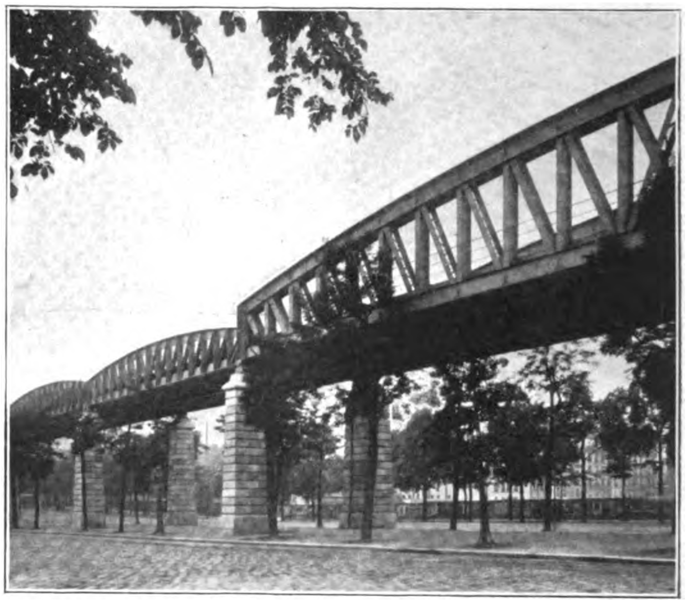

FIG. 3.—VIEW OF ELEVATED STRUCTURE.

An unusual difficulty was met with in constructing the tunnel in a part of this section. In one region the tunnel passes through the ground occupied by the ancient Catacombs. These galleries are superposed in eccentric fashion and form a series of labyrinths. On this account the ground is anything but solid, and special precautions had to be taken in order to consolidate the ground at the points where the tunnel passes for a length of 2½ miles. In the parts where the galleries are well preserved, the walls of the tunnel are upheld by sustaining pillars of masonry which are spaced at intervals of 4 meters. In the parts where the roof of the galleries had fallen in, leaving large spaces underground and forming a loose soil, the masonry pillars could not be used. It was necessary to sink wells down to solid ground, which were then filled up with concrete. This gave a solid foundation to uphold the tunnel. The pillars were braced across by masonry arches and upon the latter were built the side walls of the tunnel. In this way considerable work had to be done in order to consolidate the soil, and no less than 45,000 cubic meters of concrete and masonry are now buried in the ground in this region. This work entailed a cost of $400,000, outside of the regular tunnel construction.

The trains which are now running on the Metropolitan are made up of motor cars and trailers. The cars have a central passage, resembling the American type. The motor cars have a separate compartment at one end which is fitted with the controller and other apparatus for the motorman. Sliding doors in the side of the car have been adopted in order to save time in entering or emptying the car. The motorman has access to the cabin by a small door in the end of the car. First and second-class cars are used; the external appearance is the same, and the only difference lies in a slightly better finish in the interior.

The arrangement of the train differs according to the needs of the traffic. Thus, in certain hours of the day, when the traffic is light, a four-car train is employed. It is made up of a motor car and three trailers. In hours of heavy traffic two such trains are coupled together to form a single train of double capacity or about 100 tons load. The usual method of coupling is to place a motor car in the front of the train and a second in the rear. The cars have two motors each. These are of the double-reduction type, with a motor placed on each axle of the car. Some of the cars are equipped with Thomson-Houston and the remainder with Westinghouse material. Both have proved quite successful up to the present. The Thomson-Houston motors are built for 150 horse-power and work on 500 to 550 volts. The motors have been built at the Paris shops and weigh 2.5 tons when complete.

Since the very disastrous fire which occurred in the tunnel of the new section, in which two trains were burned and a great number of lives lost, measures were taken to avoid the recurrence of such accidents in the future. A new type of car has been adopted which will be entirely fire-proof. The car body is to be built of metal, combined with fibro-cement or asbestos board. The motorman's cabin, which occupies the front part of the car, will be considerably enlarged and at the same time separated by two fire-proof partitions from the part of the car occupied by the passengers. The two partitions will have a space of one foot or more between them, thus leaving an air space. This disposition will give a good protection for the interior of the car in case a fire should occur in the cab. Advantage has been taken of the enlargement of the cab to place the starting resistances for the motors in this part of the car. At present the resistances are placed underneath the car, where it becomes difficult to look after them.

The new car will be somewhat shorter than the present form. This will diminish the distance between axles and allow the car to pass more easily around the sharp curves which occur on the lines. These projects have been submitted to the Administration and there is no doubt that they will be carried out before long, and there will be but little danger from fire to the train. Should a short-circuit occur there will be little or no combustible material, and consequently the damage will be but slight.

A number of new sub-stations have lately been constructed in order to supply current for the new lines, and others of similar disposition are soon to be built. The current for the Metropolitan lines is furnished by the large central station which has been recently described, and the primary current, which is generated at 5000

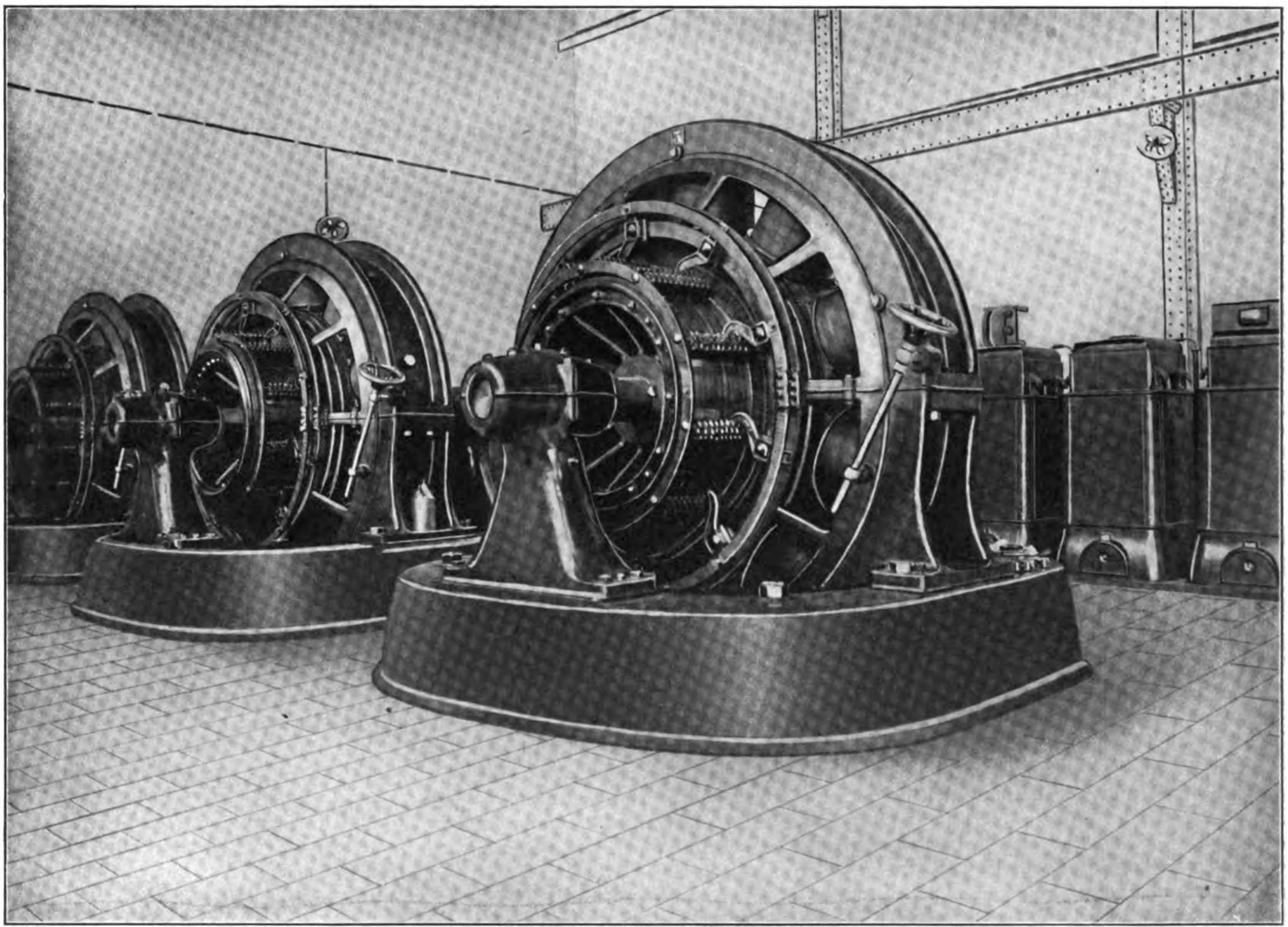

FIG. 4.—BARBE'S SUB-STATION OF THE PARIS METROPOLITAN.

volts and 25 cycles, is sent through underground feeders to the sub-stations, which are located at different points of the city. The sub-stations lower the voltage and furnish direct current at 600 volts for the third rail. Two of the largest of the new stations are illustrated herewith. At present there are five stations in all, which furnish current to the new and the old lines. The equipment of all the stations is about the same, only differing as to the capacity of the transformers and rotaries. Two of the stations are underground and are placed in masonry chambers under the street. The three others are overhead.

One of the newest of the sub-stations is shown in the engraving. It is known as the Barbe's plant and supplies part of the northern branch. This station contains three complete groups of transforming apparatus. Each group includes a six-pole, 700-kw. rotary converter of the Thomson-Houston pattern, built by the Postel-Vinay Company, of Paris, and a bank of three transformers of the same make.

Fig. 1 shows the Pére Lachaise sub-station, which is one of the largest and has recently been equipped with five groups of transforming apparatus of 700 kilowatts. Each of the rotary converters has a bank of three transformers and the general arrangement is the same as before. These stations have a switchboard for the primary and another for the secondary circuits. The transformers are placed over a pit and are cooled by a motor-driven fan.

The primary current is brought to the different sub-stations by three-conductor, lead-covered cables. The circuits which supply the sub-stations have been laid out so that the latter can be fed either from the Metropolitan central station or from one of two other large stations in the city belonging to private companies, the Triphase and the Moulineaux plants, and contracts have been made with the two companies to furnish current when needed.

One of the most difficult pieces of work in the construction of the new lines has been the crossing point of three tunnels which lie under the Place de l'Opera. At this point there are three lines which cross each other, and the tunnels are superposed one above the other at different levels. In order to provide for the crossing of the tunnels so as to allow the future work to be carried out in the lower part without interfering with the upper tunnel it was decided to build a solid structure at this point which should serve to hold the three tunnels. The rails of the lowest tunnel lie as low as 16 meters below ground. What made the work especially difficult is the presence at that depth of a stratum of water-logged sand. Accordingly, it was decided to build the structure upon three masonry pillars.

The three pillars were sunk by means of compressed-air caissons through the sand layer 20 meters below ground. This afforded a solid foundation, which supports a system of arches and iron work. This is arranged in the form of a hexagonal block embedded in the ground and flush with the surface. The three tunnels run through the block and each is independent of the other, so that future work can be carried on in the lowest line without hindering the traffic in the upper line, which will be the first to commence operation. The lower lines will be completed later on. The three masonry pillars which serve for the foundation have sections of 8 by 16, 20 by 8 and 25 by 8 meters, respectively. Upon this is built a series of masonry walls, while the flooring and roof of the tunnels are formed of I-beams. The walls of the masonry construction are finished at the top by a roofing of metallic beams, which support the roadway overhead. Each of the new lines will have a large underground station at this point and these will communicate with each other by stairways. The lowest station's platform will be at a depth of 15 meters. Spaces have been left for elevator shafts, and it is expected to equip the lower stations with electric elevators. At present this construction is finished and the roofing at the street level is being put in place.

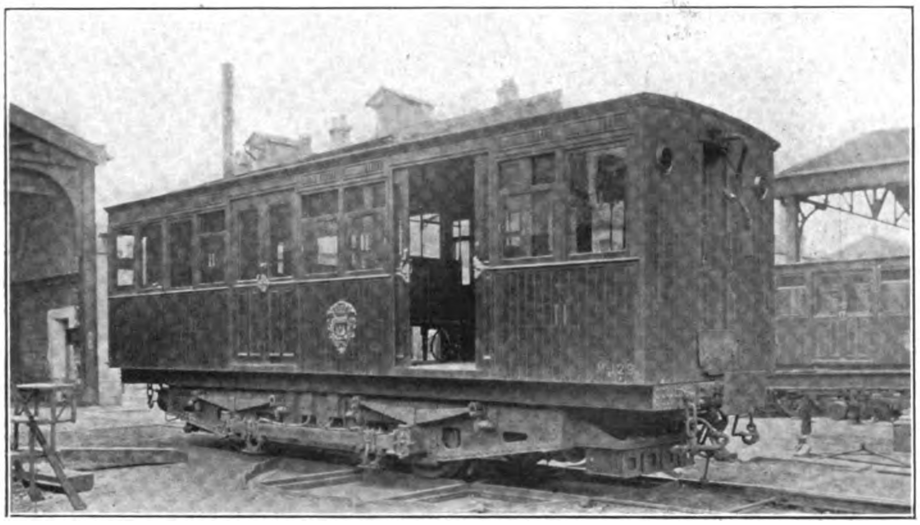

FIG. 5.—VIEW OF OLD TYPE OF MOTOR CAR.

RAPID TRANSIT AND THE ELECTRIC LOCOMOTIVE.

BY HOWARD S. KNOWLTON.

The development of the electric railway illustrates a remarkable process of evolution. Although the changes in methods and equipment which have marked the growth of electric transportation during the past ten or fifteen years are for the most part logical, they have revolutionized many phases of urban life, and have greatly influenced even rural existence. Step by step the electric motor has advanced in its conquering progress, until to-day, having almost completely driven the horse from the rails, it threatens the long held supremacy of even the steam locomotive.

Street railway traffic in cities and towns has nearly always been handled best by individual motor cars, although the use of trailers in rush hours still meets with favor in Chicago, and even in some cities as small as Denver. In general, however, the electrict locomotive finds the crowded street a poor field of action, and its economical use has come to require a private right of way as a prime necessity. Even the elevated railway and subway systems of New York, Boston and Chicago have inclined to the use of self-propelling cars within the last three or four years through the successful operation of the so-called multiple unit system, which enables any number of cars to be run grouped together in a single train, controlled by one man from the platform of any car. Strictly speaking, an electric car which hauls one or more trailers along a track is a locomotive, but the railroad man classifies it more correctly as a "motor car," reserving the title of "electric locomotive" for a piece of rolling stock whose end and aim is to haul other cars and which generally does not carry paying passengers.

Up to the present time the electric locomotive has found but a limited use in railway work. For some years it has been used extensively for hauling trains of ore cars in mines, and to a large degree it has proved convenient and economical in the handling of raw material and completed products in the yards of manufacturing establishments. Perhaps the only notable application of electric locomotives to heavy railway work has been the adoption of these machines nearly ten years ago by the Baltimore & Ohio Railroad for the purpose of hauling trains in the well-known Belt Line Tunnel at Baltimore—an enterprise which bears the reputation of entire success. The time has now arrived, however, for a battle royal between electricity and steam in suburban service, and in its choice of electric locomotives for the handling of all traffic within twenty-four miles of New York on the Harlem division, and within thirty-four miles on the Hudson River division, the New York Central road has driven the entering wedge which may finally displace the steam locomotive from the suburban field. The great Pennsylvania railroad station to be built in New York and its approaching tunnels are of like significance, but the electrification of strictly suburban service on the former road will be more complete from its beginning, according to present plans. Ultimately there is little doubt that electric trains will be run in an hour and a half between Philadelphia and New York—a distance of ninety miles. It requires no great stress of imagination to picture the day when the entire main line of the New York Central system from New York to Buffalo will be operated by electricity generated by Niagara and Hudson River power. That day may be long in coming, if the conservatism of the past be a criterion, but the future prospects of more costly fuel will have their share in causing the transition to be made. It is a great mistake, however, to assume that the steam locomotive is at present on the road to the scrap heap because two large trunk systems have adopted it for suburban service outside a single city. Some serious limitations attend the application of electricity to general railway service, and there are many obstacles to be overcome before the iron horse can suffer race extinction. Before considering some of these limitations it is worth while to touch upon some of the salient points of the New York Central's recently ordered electric locomotives and to compare them with the gigantic steam-driven machines which haul the bulk of traffic on existing railroad systems. Realizing that the technical press has already briefly described these electric locomotives, the writer hopes to accentuate their striking features without undue repetition.

Small resemblance exists between these electric locomotives and their steam prototypes. The frame is of cast steel; the wheels and trucks are of substantial design also; but the absence of the usual enormous boiler, cylinders, connecting rods, stack and tender results in an affair which looks more like an iron box mounted on wheels than anything else. The cab is built in the middle of the locomotive, and the machine will run equally well forward or backward without turning around. Of course, the steam locomotive will do the same thing, but the electrical horse has no front and rear ends, each end being front or rear according to the direction which happens to be taken. Practically none of the mechanism is visible—a marked contrast to the old-time locomotive. The new machines are equipped with electrically driven air compressors for operating the brakes and whistles, a bell and sanding device, and an electric headlight at each end. The cabs will be heated by electricity, and the motive power is furnished by four 550-h.p. motors capable of being overworked up to a total of 2800 horse-power. This means that each machine is half as large again as the largest steam passenger locomotive in existence, as far as power is concerned. They are designed to pull light trains at speeds as high as 75 miles per hour, and when it is desired to make fast time with the heaviest limited Pullman trains, two electric locomotives can easily be coupled together and operated by a single driver. This is made possible by the multiple unit control system, which is very similar to that used on the Boston and Manhattan elevated trains.

It is interesting to compare the electric machines with a typical surburban steam passenger locomotive, such as is used by the Philadelphia & Reading Railroad. The electric locomotive weigh 95 tons, against the steam's 100; the length of track occupied by its wheels is but 27 feet, against its rival's 30 feet 9 inches; its driving wheels are but 44 inches in diameter, against the Reading engine's 61⅝ inches, while the steam machine has a "tractive effort" or horizontal pulling force of but 18,000 pounds, compared with 22,800 pounds in the electric locomotive. Even the latter can be considerably exceeded for short intervals without injuring the motors. Comparing the New York Central machine with one of the largest passenger locomotives in the world—the 175-ton engine of the Santa Fé system—the steam machine requires 62 feet 10½ inches of track to accommodate its wheels, or more than double the length taken up by the electric locomotive, while with a weight of 74 tons upon its 69-inch driving wheels it can develop but 22,200 pounds horizontal pull. In other words, the Reading engine, especially designed for rapid acceleration, has a pulling force of but 180 pounds for each ton of its weight; the Santa Fé machine has 127 pounds tractive effort per ton of its bulk; while the New York Central outfit will easily show 240 pounds tractive force per ton of its weight. A great advantage of the electric locomotive in this connection is the uniform pull exerted throughout each revolution of each driving wheel, made possible by the rotary motion of the motors, as contrasted with the reciprocating mechanism of the steam engine. This means, of course, that the electric trains can attain full speed in a much shorter time than trains propelled by steam.

Several other striking advantages are noteworthy. The electric locomotive entirely does away with all the cinders, soot, smoke and disagreeable gases now inseparable from steam railroad travel; it is easier on the roadbed and track, because there are no unbalanced parts in rapid motion which pound the rails at every turn of the wheels; it allows tunnels to be traversed in comfort and with much greater safety, as there is no obstruction of signals by a smoky atmosphere; it takes up less room in stations and roundhouses, requires no stopping for coal or water, and suffers no delays due to tardy "firing up" before runs; it wastes no energy when standing still; involves no possible danger of explosions and consequent loss of life; it is but one-half as likely to be totally disabled as is its steam-driven competitor; and last, but not least, the electric locomotive demands no incessant shoveling of coal to the point of physical exhaustion by a fireman. Then, too, it is probable that the cost of keeping the newer machine in good trim will compare very favorably with the maintenance or ordinary locomotives, in view of the large duplication of simple and rugged parts in the electric locomotive and the absence of complicated valves, piping, link motions, balancing mechanism, etc. Certainly the electric machine can be very easily handled in the repair shop in the absence of the tremendous boiler common to all modern high-powered locomotives. It is difficult to realize the change in comfort which the application of the new service to the New York Central tunnel in New York will inaugurate.

Electric locomotive traction has to win its spurs, however, before it can be generally applied to railroad service in widely separated parts of the world. It has not been demonstrated thus far to the satisfaction of hard-headed transportation experts that it is enough cheaper than present methods to warrant its adoption in cases where traffic is not extremely congested. One must not imagine that the elimination of many of the inconveniences of steam locomotion means that the adoption of electric motive power has no drawbacks. Breakdowns in equipment cannot always be prevented, even with motive power designed for continuous service, and the light of much experience is needed before the conservatism of the steam railway world can be convinced that electricity can be commercially applied to trunk line operation. We may escape "leaky boilers," "poor coal" and "low steam" only to find ourselves delayed by "short-circuits," "blown fuses," "armature burn-outs," "poor contacts," and other sources of failure; the snapping of overhead wires, and accidents to which powerhouse engines are liable—all are fraught with power to incur great inconvenience. The very concentration of the power supply in a few large prime movers makes any delay or accident all the more serious. The bursting of a single steam pipe may tie up a whole division—something most improbable with present methods of operating railways, where each engine carries its own power station upon its trucks. It is not easy to exaggerate the loss in time and money which would result from even an hour's blocking of the suburban traffic of a great railroad system like the New York Central through the failure of some small but important link in the chain of energy transformations which connects the power-house coal pile with the wheels of the electric locomotives. At the best, the adoption of electric motive power means increased complication of equipment in power-house, line and substation, or distributing point, construction. There are many unsettled operating and maintenance problems which only experience can solve. The handling of suburban traffic of a city like New York or Boston, complicated as it is with transcontinental through travel, is a very different proposition from operating either street or elevated cars and trains.

Within the last few months many absurd assumptions have been made by enthusiastic writers regarding the high speeds which can be attained through the use of electric motive power. These assumptions have largely been based upon the now famous Berlin-Zossen tests, in which a maximum speed of 131 miles per hour was actually reached upon an experimental line built and operated without regard to cost for the sole purpose of securing data upon the uncertain features of high-speed electric railway operation. Although no special difficulty was encountered in running at this speed after the track, roadbed and rolling stock had been brought up to the pitch of perfection which safety demanded, the results of the trials showed conclusively that for the present, at least, such high speeds are not commercially practicable. The gain by running so fast does not justify the expense as a business enterprise. Mr. Arthur M. Waitt, recently superintendent of motive power on the New York Central road, not long ago said, in regard to high-speed operation:

"To one who has not had constant experience in running at high speeds on a locomotive, it may be a matter of surprise to know that it is not infrequently the case that engineers hauling such high speed trains as the famous Empire State Express in coming to a terminal station after a 140-mile run are so completely exhausted and devoid of physical as well as nervous strength as to be hardly able to get down from their engines, this being especially the case where trains have been late and it was necessary to make extremely high speed. When it is realized that the average speed of the Empire State Express is considerably less than 60 miles an hour, it will be seen that the nervous strain upon an operator by increasing the average speed to say, 75 miles an hour, would be almost beyond human endurance, at least for any great length of time, so that when high speeds are considered in the future, the nerve endurance of the operators of trains will have to be given careful consideration."

The great field of electric locomotives in rapid transit is that of suburban transportation, and even this field is to some degree limited. Short interval train service is a prime necessity. Where the headway of trains exceeds half an hour, roughly speaking, there is great danger of wasting money in attempting to handle the traffic electrically. Trains of from one to four cars can be operated at half-hour intervals or less, where the traffic demands such frequent service, better by electricity than by any other known motive power. In some cases branch line electric operation will be found advisable as the art advances. The day is not yet apparent when the haulage of long, heavy freight and passenger trains at wide intervals over long stretches of sparsely settled country can be profitably done by electric to the exclusion of steam locomotives. The electric railways have much to teach the steam lines of the country, but the experience of the latter, bought by more than half a century of practice, must be well considered in any future work undertaken. The requirements of twentieth century transportation are not going to relax, and the high speed electric service of the future sorely needs, in the interests of safety and economy, the best thought which long years of operating experience can produce.

PURIFYING BOILER FEED-WATER.

BY R. T. STROHM.

One of the greatest sources of trouble and worry in the management of steam boilers is impure feed-water, and there are very few plants that are wholly free from this bugaboo in one form or another. Most commonly, the impurities are of such a nature as to form what is known as boiler scale, which is a deposit of sediment and mineral matter on the water surfaces of the plates and tubes. This deposit may be soft or hard, light or heavy, and varies in composition in different localities. In all cases, however, its deleterious effects are the same. It retards heat transmission and renders the plates and tubes liable to overheating.

Not infrequently, the feed-water is corrosive in its nature, and in this condition it attacks the iron of the shell and tubes, eating away the plate, rivets and stays, weakening them, and rendered the boiler unsafe at the original working pressure for which it was designed. Of the two evils, scale and corrosion, the latter is by far the more insidious and difficult to detect. Indeed, it is frequently almost impossible to notice it, especially if the area which is corroded is of considerable extent and the corrosion is uniform in depth and character. In such a case, if corrosion is suspected, a hole may be tapped into the plate to determine its thickness, after which a plug may be screwed in to prevent leakage. If the corrosion is confined to spots, or small areas, it will reveal itself very easily, and the depth of the indentations can be determined by mere inspection.

The impurities in the water which cause scale and corrosion may be absorbed by the water in either of two ways. Water being a universal solvent, it takes up various mineral substances with which it comes into contact as it filters through the earth, or drains off the surface into the rivers and lakes. The amount of impurity thus absorbed depends upon the nature of the soil and the season of the year. For it is acknowledged to be a fact that during prolonged periods of dry weather there is more rapid scale formation than during the rainy season. The explanation lies in the fact that during the continued drought, the water supply has been for a longer time in contact with earthy material, and is therefore impregnated to a greater extent than during the wet season, when much of the water is simply surface drainage instead of having percolated through the earth. On the other hand, the surface water is liable to contain much organic matter, of vegetable and animal origin.

The second method by which water may become impregnated with impurities is by reason of pollution from the discharge of refuse from chemical and other manufacturing establishments located on the banks of streams or lakes, or by the sewage from towns and cities similarly located.

The treatment of boiler feed-water is, in many ways, analogous to the treatment of bodily ailments. There are a large number of different impurities just as there are numerous physical ills. Each of these must be treated in a specific way, just as a bodily illness must be treated according to its nature; and before any intelligent idea of the means of treatment can be arrived at, it is necessary to analyze the water and discover the amount and kind of impurities, just as it is essential to diagnose a case of illness to determine the procedure to effect a cure.

Boiler feed-water may be purified by any one, or more, of three separate means. First, by the use of heat; second, by the use of filters, and third, by the use of chemicals. In the first class, the action is purely thermal. In the second, it is simply mechanical. In the third, definite laws of chemistry are brought into play.

The purification of feed-water by the action of heat, supplied either by live or exhaust steam, was touched upon in a previous article dealing with feed-water heating. This was unavoidable, as the heating and the purification are so closely allied in many cases as to preclude individual treatment. There is this point to be observed, however: Exhaust steam heaters cannot raise the temperature of the feed-water above the temperature of boiling water under atmospheric pressure, which may be taken at 212° Fahr. Now, if there are no other impurities in solution except carbonates of lime and magnesia, the exhaust feed-water heater will do very well, since it will not only return a considerable amount of heat to the boiler which might otherwise go to waste, but it will raise the temperature of the feed-water sufficiently to precipitate the carbonates. But if the sulphates are present, no amount of heating by exhaust steam will purify the water. A live steam purifier which will raise the temperature of the water to approximately 300° Fahr. is the sole recourse in this case. The principle involved in the action of this purifier is simple. Sulphate of lime and sulphate of magnesia are both readily soluble in cold water; but they are just as insoluble when the water is above 290° Fahr. Consequently, by raising the temperature beyond the point of solubility, these impurities are precipitated. The desirability of freeing the water from these sulphates before feeding it to the boiler may be realized when it is stated that of all scale-forming substances these are the most to be dreaded, because of the hardness and tenacity of the deposits when once they are baked upon the tubes and plates. The removal of this incrustation then becomes a matter of considerable hard work for the fireman, done in a most uncomfortable position, especially in cleaning the shell of a return tubular boiler.

The precipitation of these impurities by heat is not a process which begins and is completed in the instant during which the water acquires the necessary temperature. The precipitation is gradual, and extends over a considerable period including temperatures, both below and above 290° Fahr. Hence, it is not reasonable to expect that a feed-water heater and purifier will wholly prevent the formation of scale in the boiler.

To do so, the heater would need to be of such capacity that precipitation would be complete before the water left it. Also, the rate of flow of feed water would need to be so slow that none of the precipitated impurities would be carried along with the current, into the boiler. In the great majority of cases close competition in the heater trade has reduced the size for a given amount of work to the minimum, and it is doubtful whether many purifiers do more than a part of the precipitating within themselves. It is much more common to find a heater too small for its work than to find one which is too large. Yet, it must be apparent that it is far better to err on the side of too great, rather than on the side of insufficient, capacity.

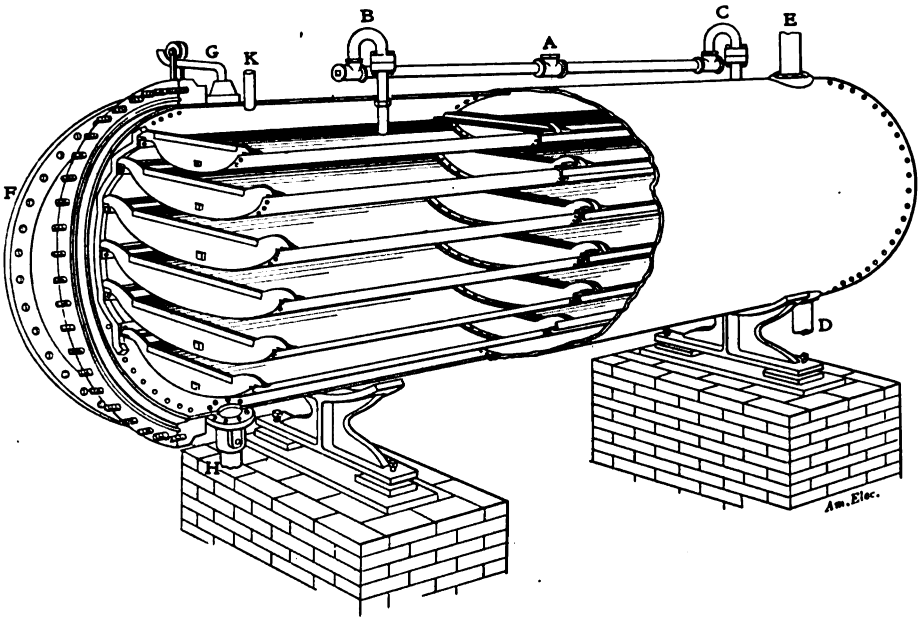

FIG. 1.

A live steam purifier which has many good points in its construction is illustrated by Fig. 1. It consists of an outside cylindrical shell made of steel plates riveted together, since the purifier is subjected to boiler pressure. A number of parallel bars of angle iron are riveted to fittings and extend longitudinally from end to end of the shell, forming supports for a number of tiers of pans. These pans are slightly dished, and are made of thin steel plates riveted to cast iron ends. The feed-water enters at *A*, and is distributed by the branch pipes *B* and *C* so as to be discharged into the upper tier of pans. From these upper trays it overflows into the second, then into the third, and so on until the bottom of the heater is reached, after which it is drawn off at *D* and allowed to flow into the boiler. It is evident that since the interior is filled with steam at boiler pressure, the water will flow by gravity into the boiler, if the heater be placed at a slightly higher level than the water level in the boiler.

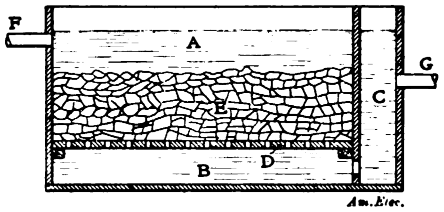

FIG. 2.

The live steam enters at *E*, and, coming into contact with the cooler water, heats it to a temperature sufficient to cause precipitation of the impurities. This action is hastened by reason of the fact that the water is broken up into many thin sheets. The precipitated impurities adhere to the pans and accumulate until it becomes necessary to clean the purifier. To do this, the head *F* is removed and swung out of the way by the crane *G*. Then the pans are taken out and the scale knocked off them. To facilitate this cleaning operation, the pans are divided at the middle, instead of extending the full length of the shell. The pipe *H* connects to a blow-off and serves to remove much sediment. A gauge glass is placed between the pipes *K* and *H* to show the amount of water in the purifier at any time.

One of the particularly important features of this purifier is its capacity. From the relative sizes of the inlets for water and the shell, it will be seen that the water must travel some length of time before it can leave the heater. This furnishes ample opportunity for the greater part of the precipitation to occur within the heater, leaving the boiler free from deposits of scale of any serious consequence. The large amount of surface exposed to catch the impurities is another valuable feature, while the troughs formed by the pans or trays serve to catch and retain the larger portion of the mud which may be carried in with the feed-water.

Filtering of the feed-water is resorted to only when the impurities are mechanically suspended in the water and can be removed by a straining through some such medium as coke, charcoal, hay, cloth, pebbles or the like. The impurities which may be removed by these means are mud, sand, oil, organic matter, and, in fact, all matter which is not in solution or in chemical combination with the water. Muddy water may be purified also by simply allowing it to stand for some time in settling tanks, with little or no circulation, when the mud will be precipitated by the action of gravity. The size of storage and settling tanks which would be required for a large plant makes this method impracticable, except in small installations. To be effective and continuous in operation, filters should be in duplicate. For, as the filtering medium removes the impurities from the water, the efficiency and capacity must eventually lower, due to the clogging of the passages. While one filter is being cleaned, then, the other may be used. This assures a clean filter always in readiness for any emergency. The filtering medium should not be expensive, and the construction of the filter should be such as to make it easy to clean. A simple and cheaply constructed filter is illustrated in Fig. 2. It consists of a wooden tank having three compartments, *A*, *B* and *C*. A perforated bottom *D* divides chambers *A* and *B*, and on this is placed a thick bed of coke *E*. The water enters at *F*, filters through the bed of coke and drains into the chamber *B*, and thence into the pump chamber *C*, from which it is drawn by the pump attached to the outlet pipe *G*. Any particles of coke or sand which may pass through the perforated bottom will collect in the chamber *B*, and cannot rise to the outlet *G*, thus preventing their getting into the pump.

It is true that frequent blowing off of a boiler will tend to prevent the deposit of heavy scale, since much of the precipitated matter will be ejected before it has had time to adhere and bake to a crust. Nevertheless, it is wise to guard against admitting the impurities at all, by using some means of separation outside the boiler; for there are some impurities which cannot be expelled by the use of the bottom blow-off. They are the lighter ones, which float as a scum at the surface of the water, and the most effective method of removing them is by the use of a surface blow-off or by a skimming device.

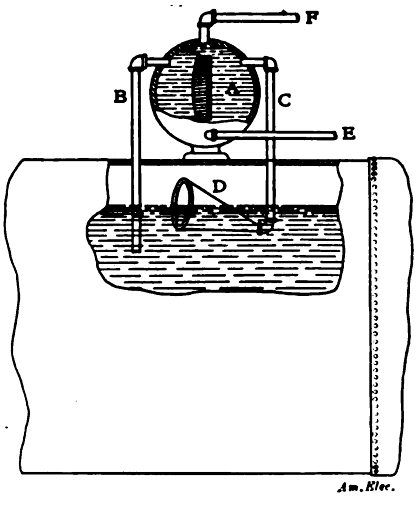

FIG. 3.

One form of skimmer is shown in Fig. 3. It consists of a spherical vessel *A* located above the boiler shell. A diaphragm divides the vessel into two chambers, into each of which leads a pipe, the pipe *B* connecting with the water space of the boiler and the pipe, *C*, connecting with a funnel-shaped casting, *D*, whose mouth is toward the front of the boiler. The diameter at the mouth is such that no matter how much the water level may vary within its usual limits there will always be some surface water in the funnel. Since the circulation in a return tubular boiler is from front to rear at the surface, the scum is carried into the funnel, and thence up the pipe *C* into the spherical vessel. Here the water is cooled and the sediment is deposited, after which it is blown out through the pipe *E*. The lighter scum, such as oil and the magnesia salts, rise to the upper side of the globe and are blown out through the pipe *F*. The purer feed-water then descends by the pipe, *B*, into the boiler. The circulation is continuous, and is maintained by reason of the fact that a column of cold water is heavier than a column of equal height composed of hot water and steam.

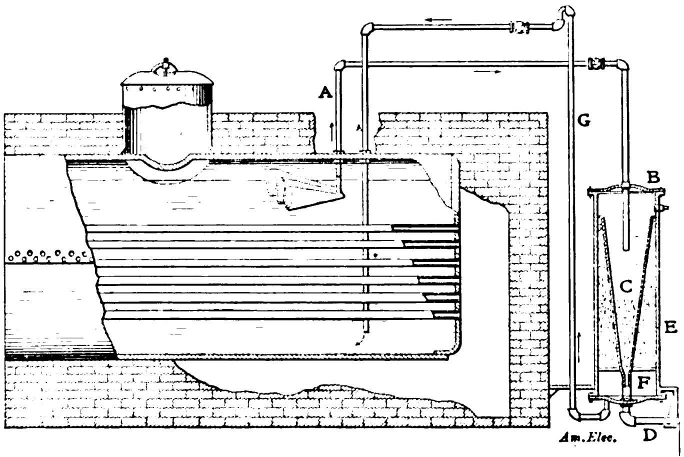

FIG. 4.

A mechanical cleaner of greater capacity and more elaborate construction is shown in section in Fig. 4. It has three funnels for gathering the sludge, and they are connected to a common discharge pipe, *A*, leading to the settling chamber *B*. The settling chamber is a vertical shell containing an inverted conical chamber *C* into which the scum and sludge are led by the pipe *A*. The lower end of this cone terminates in a blow-off pipe *D* through which the impurities that collect are blown out at frequent intervals. The water, after, being freed of its impurities in the chamber *C*, rises and flows over the upper edge of the cone, and then trickles downward through the bed of filtering material *E* surrounding the inverted cone. By the time it reaches the chamber *F* it is comparatively free from impurities, and it is then returned to the boiler by the steam loop *G*. The use of three funnels at the surface of the water gives greater opportunity for collection of scum. The action of this device, as well as that of the cleaner shown in Fig. 3, is continuous so long as the boiler is in operation, and the rapidity of flow may be regulated by a valve on the discharge pipe connected to the funnels.

The use of chemicals to purify boiler feed-water has reached enormous proportions during recent years, and there are a score or more of manufacturing concerns whose sole business is the preparation of boiler compounds. The usual procedure is to obtain samples of the feed-water and of the scale produced from it. These are analyzed quantitatively, and the exact amount of each impurity per gallon of water is found. Then a compound is prepared containing chemicals in such proportions as to just neutralize the evil effects of the impurities, or to change the latter into some other form which shall be harmless and easy to remove.

For example, suppose that a feed-water contains sulphate of lime and sulphate of magnesium. These would form a hard scale; but if carbonate of soda is added in correct amount, the sulphates are changed to the carbonates by the chemical action which takes place. So, instead of water containing sulphate of lime and carbonate of soda, there results carbonate of lime and sulphate of soda. Similarly the sodium carbonate changes the sulphate of magnesium to magnesium carbonate and itself becomes sodium sulphate. Now, the carbonates of lime and magnesium are insoluble in hot water, and consequently the former is precipitated to the bottom of the boiler, whence it may be blown out, while the latter floats and may be removed by a skimming device. The result of the chemical action has been simply to change a harmful salt into a harmless form. The sodium sulphate formed is readily soluble in the water, and hence is at once taken up, leaving no precipitation.

And thus it is with all purifying compounds. They act chemically upon the water so as to form new compounds which are harmless and easy of removal. But it should be borne in mind that for every different impurity a different style of treatment should be applied. It is just as absurd to suppose that one kind of boiler compound will cure all cases of scale formation as to expect one medicine to cure all bodily ills. And, finally, it must be remembered that a boiler compound does not destroy the impurity utterly. There will always be a residue which must be removed at intervals if the boiler is to remain efficient in its service. The advantage is that the sludge may be blown and flushed out, whereas scale would require chipping and knocking, with probably injury to the plates and tubes.

◆

The cost of electric power at Ilford, England, is, according to the city electrical engineer, 4.8 cents per kilowatt-hour sold. This is based on the last year's costs, and includes sinking fund and interest charges.

AUTOMATIC BLOCK SIGNALS.

BY RALPH SCOTT.

Siding Protection.

It is important that where a long siding or crossing exists, that this siding be protected so that it resembles in itself a short section of track. An arrangement for accomplishing this protection is shown in Fig. 27. The crossover *b* is connected to a track battery and to the relay *a*. This relay has two armatures *e*, one of which is in series with the home signal line wire *c*, the other in series with the distant wire *d;* this relay thus protects against a train being across the crossover, which would not otherwise effect the signal.

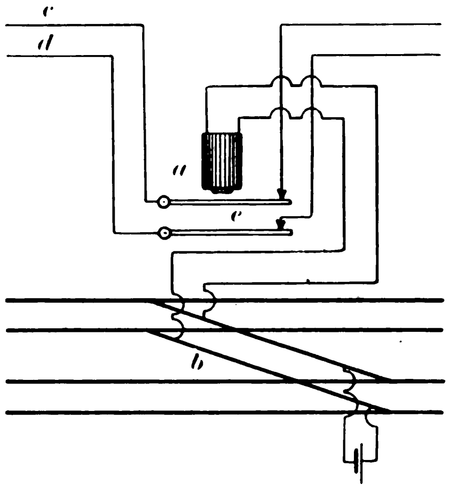

FIG. 27.

Crossing Signal Circuits.

Although railroad crossing signals are not usually considered in the same light as the automatic railroad signal, since they are automatic in their action, there exists but little difference between these and the railroad signal.

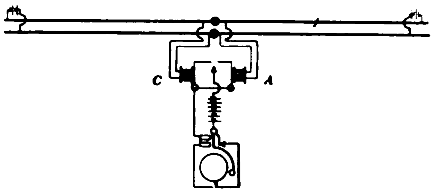

FIG. 28.

In Fig. 28 a simple crossing signal is shown, which announces, by the operation of a bell, the approach of trains, when within the limits of the block, in either direction. Connected to the two insulated sections, across the rails of which the difference of potential is maintained by the usual track batteries, are the relays *A* and *C*, which close the circuit of a bell. The bell and relay are stationed in a post placed at the

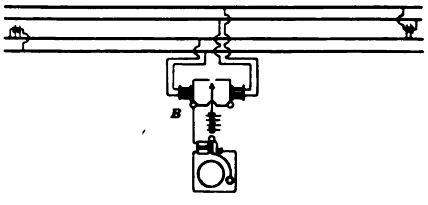

FIG. 29.

highway to be protected. When either track section is short circuited by the movement of a train, the armature of either relay causes the bell to be connected to the battery in the manner shown. The armatures of these relays are of a construction which

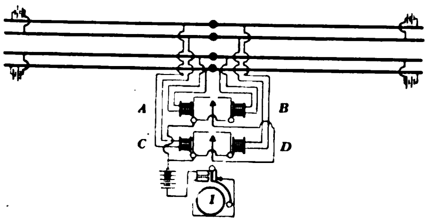

FIG. 30.

gives a contact with a scraping motion, as will be evident from the diagram.

The arrangement of a crossing signal for a double track system is shown at *B* in Fig. 29. This arrangement announces the approach of trains on either track in either direction; the connection, otherwise, being similar to that above described.

Another double track arrangement for

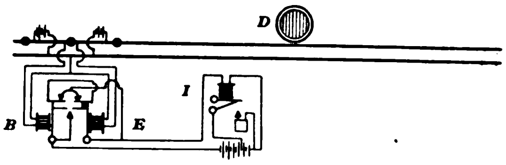

FIG. 31.

single track movements is shown in Fig. 30, four relays, *A, B, C* and *D*, being used in this case; these operating a bell *I*, through a battery common to all the relays. With the exception that four insulated cut sections with their batteries and relays are required, this system is similar to the above, giving, however, more reliable protection.

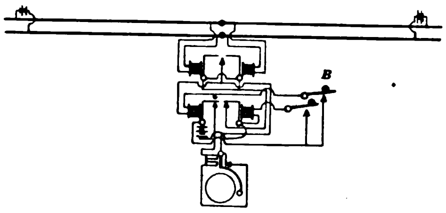

FIG. 32.

The circuit arrangement shown in Fig. 31 has two short, insulated rail plates, connected with batteries to the uninsulated rail and also to the relays *B* and *E*. These relays operate an indicator *I* in the tower *D*, thus warning the gateman in this tower of the approach of a train. This drop will, therefore, warn the tower attendant of all trains approaching the tower from the direction of the insulated section, but not the trains receding from the same.

In Fig. 32 an arrangement for manually stopping the bell while the train is on the track circuit is shown, this operation being performed by the keys *B*, which control the relays connected to the bell, operated by either track section. The bell, however, is automatically rearranged for the next operation.

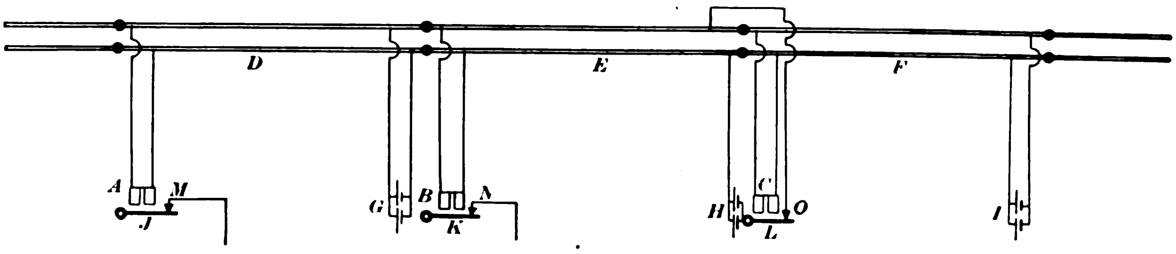

FIG. 37.

In Fig. 33 the same arrangement is shown with the exception that the train automatically starts the bell *A* when it has reached the section *D*, by the action of the relay at this point.

In Fig. 34 an open circuit system for the operation of a drop, *C*, at a signal tower is shown; otherwise, this installation is similar to that shown in Fig. 28.

Simple Signa Circuits.

In Fig. 35 two methods of normal clear signal control are shown. In the upper

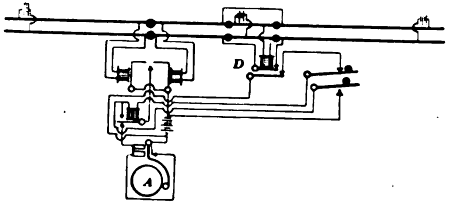

FIG. 33.

part of the figure, the entire cut section, with the relay *B* and track battery *E* is shown. This relay controls, through the battery *D*, the signal *A*, the relay *E* performing a similar function. With a train at section *C*, *A* will be held at danger, *E* being unaffected.

In the lower part of the engraving, overlap signals *H* and *J*, which are controlled by relays located at a single point, are shown. *H* is held at danger until a train has left the first block in the front of *J*, while *J* is held at danger by a train in the block between *J* and *H*. On account of its greater distance from the main battery, *H* is operated by a greater number of cells

In Fig. 36 the connection of signals, the circuits of which are mechanically operated, is shown. The signals *A* and *D* are controlled by the switch *C*. The arrangement of this signal is such that no signal can be thrown to the clear position without the other being held at the danger position. Indicators *E* and *B*, which in reality are miniature signals, show, by their indication, the condition of the signals. In the lower part of this figure the movement of the lever *F*, which is connected by mechanical means to a semaphore, closes or opens the circuit of a distantly located signal, thus apprising an approaching engineer of the position of the mechanically operated semaphore.

Track Circuit Controlling.

The relay method of signal control, which is used almost exclusively in systems which do not require line wires, is shown in Fig. 37. Connected to cut section *D, E* and *F* are the track batteries *G, H* and *I*. *G* operates the relay *A* and, therefore, controls the armature *J*, which makes contact with *M*. These latter are connected in series with the signal and its batteries. When *G*, therefore, is short circuited, the signal circuit will be open circuited.

The same arrangement is shown connect-

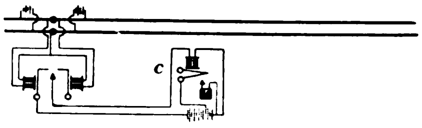

FIG. 34.

ed to cut section *E*, the relay *B* controlling a signal through the contacts *K* and *N*. The battery *H*, which operates the relay *B*, is connected in series with the armature *L* and the contact *O*, this armature being operated by the relay *C*, which receives current from the track battery *I*.

If *I* be short circuited, therefore, the armature of the relay *B* will drop, because the armature *L* falls, and thus open cir-

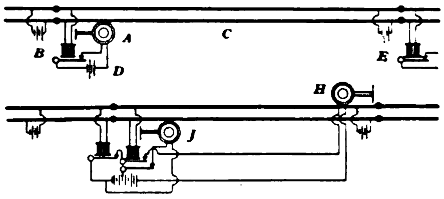

FIG. 35.

cuits the battery *H*, which creates a difference of potential across the cut section *E*. By such an arrangement, therefore, one relay may be controlled by another relay in another cut section.

Normal Clear Circuits.

In Fig. 38 a normal clear line wire system of home and distant signals on the same masts is shown. Two line wires *N* and *V* in this case are necessary. Five signals, *A*,

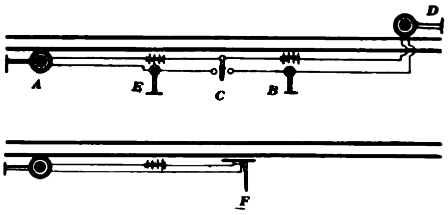

FIG. 36.

B, C, D and *E*, with their connections, are shown. A train is supposed to be across the track at *F*, thus holding the home board at *O* in the danger position and the distant board of signal *D* in the same position, the other signals being unaffected.

Describing the apparatus at *B*, which is common to all of these signals, there are: the circuit breakers *m* and *s*, operated by the home board of the signal; *m* open circuits the line wire *N*, while *s* open circuits the distant board.

The signal battery *n* is connected to one side of each board, and also to the home board through the armature of the relay *v*. This battery also gives current to the distant board of the first signal in the rear of *B*. The other connections will be readily seen from an inspection of the diagram.

In Fig. 39 the polarized or "wireless" method of normal clear control for home and distant signals on the same mast is shown. The signals *H, I, J, K* and *L* are operated by local wires and the rails of the track, which latter form the only circuits employed between the signals.

A train is supposed to be at the position *G*. Describing the accessories at signal *I* there is a polarized relay *w*, having the armatures *c* and *f* connected to the track section. On the other side of the insulating joints, the track battery *a* is connected, through the polarity changer *b*, operated by the home board of the signal, to the track section. The polarity of *a* controls the polarized relay at the signal *j*.

The signal battery *t* is connected to the home and distant boards of *I*, the other side of this battery being connected to the home board through the armature *c* and to the distant board through the armature *f*, and the circuit breaker, which latter is operated by the home board. Hence, when the home board is in the clear position, this circuit breaker is closed, and if the armature at *f* makes contact, current will pass through the distant board. The same arrangement is used at every signal.

In Fig. 40 a normal clear line wire signal system is shown with home and distant boards on separate masts; *A, C* and *E* are home boards and *B* and *D* distant boards. The switch *Y* is supposed to be open, thus short circuiting the track through the switch instrument *I*.

Signal *A* is shown in the clear position; battery *F* of this signal being connected to it through the track relay armature *J*; signal *B* receives battery current from *G*, through the armature *c* of the relay *V*; one side of the armature being connected to the common line wire, as is also one side of the battery *G*. A double relay, *a*, acts on the same armature, the lower of these being in series with the track battery, and the upper being energized when current passes through the signal. The former is connected in series with the armature *b* of the track relay *V*.

The track relay at signal *C* is provided with armatures *U, T* and *S*; *U* being in series with the switch instrument *R* and connects one side of the signal to the common wire, through this instrument. *T* is in series with one side of the signal *B* and also with the circuit breaker *Q*, operated by signal *C*. This circuit breaker connects one side of *C*, therefore, with one side of signal *B* through the line wire.

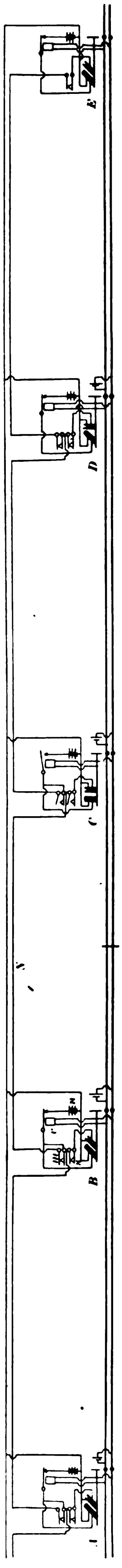
FIG. 38.

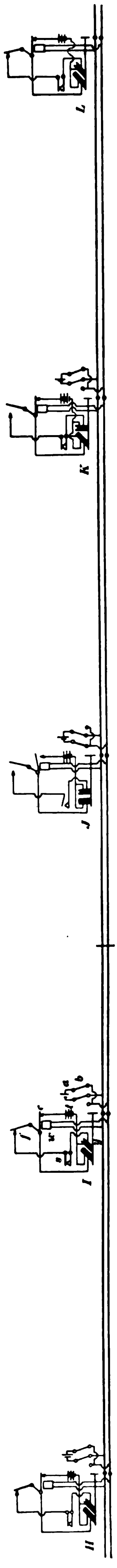
FIG. 39.

The armature *S* is in series with the armature *d*, and connects the switch instrument *P* with the battery *G* and the common line wire; when *S* and *d* are closed, therefore, the switch instrument *F* will be in the clear position. In the diagram, however, with the switch *Y* open, *F* is in the danger position, since the armature *S* breaks the circuit at this point; the armature *O* of the track relay and signal *D* connect the track battery to the track at this signal, the armature *N* connecting to one side of the signal battery through the circuit breaker at *E*, operated by the latter signal.

The track relay at this signal has two armatures, *L* and *M*, the former giving battery current to the signal *E*, and the latter connecting one side of this signal and the battery *H* with signal *D* through the armature *N*; therefore, with *N, M* and *L* in the upper position, both signals, *D* and *E*, will be held at clear.

The manner of connecting a line wire, normal clear system is shown in Fig. 41. Four signals, *A, B, C* and *D*, with their connections are given; the common line wire *Q* running the entire length of the track, and the others wire, *P*, depending in number and length upon the interconnections. In the home block of signal *A* a train or open switch is supposed to exist. The same condition of affairs exists in the home block of signal *D*. The switches *E, G* and *H* are provided with the switch indicator *O* and the switch instrument *F*. On the switch *E* the switch instrument also closes the circuit between the common and indicator wires. The signal batteries *L, K, I* and *J* are all connected on one side to the common line wire, and on the other side to the top armature of the track relays of the signal sections. Describing the accessories at signal *C*, which are common to all the other sections, there is the track relay *a*, which has three armatures, *p, f* and *o*; armature *p* connects one side of the battery *I* with the home mechanism *j*, which is in series with the relay *g*, having two armatures, *m* and *h*; *m* connects through the resistance *i* when the relay is energized, one side of the battery *I*, with the line wire, passing to the lower armature of a similar relay at signal *D*. When the home board at *C* moves to clear, the circuit closer *n* short circuits the relay *g*, thus allowing its armatures to drop. The lower armature *h* thereby sends current from the battery *I* into the switch indicator, *M* and *N*. The resistances *e* and *i* limit the current flowing through the circuits operated by the armatures *o* and *h*. The distant board mechanism *k* of the signal *C* is connected in series with the battery *I* through the armature *d*, the circuit closer *l* being operated by the home board and the instruments at the signal section *B*. The rest of the connections may be readily traced up from the diagram, it being similar to those we have already described.

In Fig. 42 a normal danger system with part track relay and part line wire method of control is shown. This constitutes what is known as an overlap system. Two signals, *A* and *B*—*A* having two sections as shown, 1 and 2, and *B* three sections, 5, 4 and 3—are given, together with an additional section, 6, to which is connected the relay controlling the battery current which operates the signal mechanism of *B*. Describing the apparatus at signal *A*, there is the track 1 connected in series with the contact *j* of the track relay *k* in section 2, and with the double functioned relay *e*, and also to the rails of the track of section 3. This relay, *e*, is known as a clearing relay. If a train be on section 4, the relay *o* will be short-circuited and thus open the circuit of the signal, *B*. The same action will occur if a train be on section 5. A train at section 4 will short-circuit the battery connections through the armature contact of *n*. This, however, does not affect *n*, for if a train be across section 3, the relay, *n*, will be short-circuited, thus causing its armature to drop and open-circuit the battery connected to section 4, and thus de-energize the relay, *o*, which drops its armature and open-circuits the battery of signal *B*. The clearing relay of the latter will close its contact, but the signal will remain at danger.

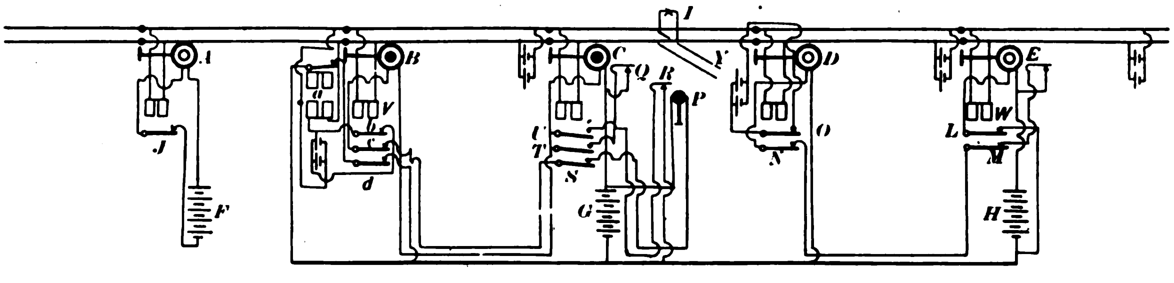

FIG. 40.

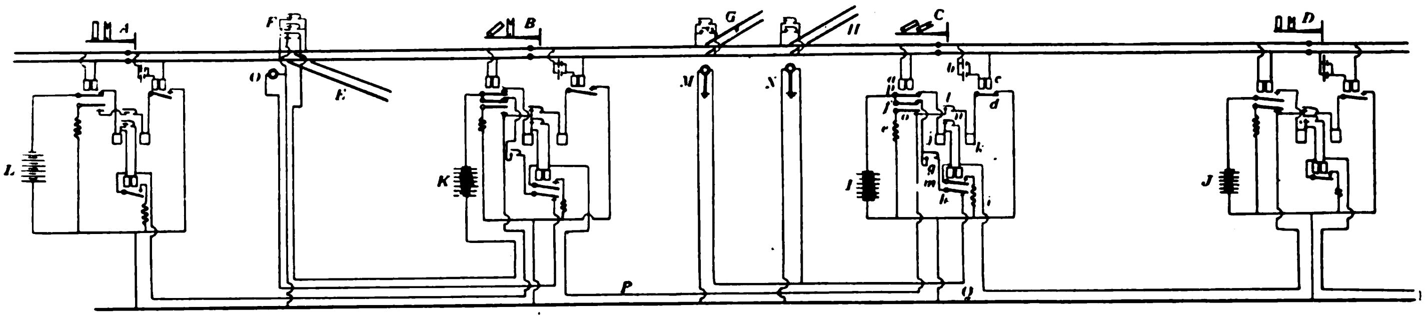

FIG. 41.

In Fig. 43 the arrangement of a normally clear circuit with the overlap method of signal control is shown. The track relay *q* connected to section 8, in the block of signal *C*, has two armatures, one of which is connected in series with the track battery of section 9, and the other, *u*, in series with the signal battery *t*. Sections 9 and 10 are controlled by the relay method. Section 12 is not connected through a clearing relay, as it is not necessary in this case. The relays connected to sections 10 and 11 have armatures which normally close the circuit of the signal battery and these hold *D* in the clear position.

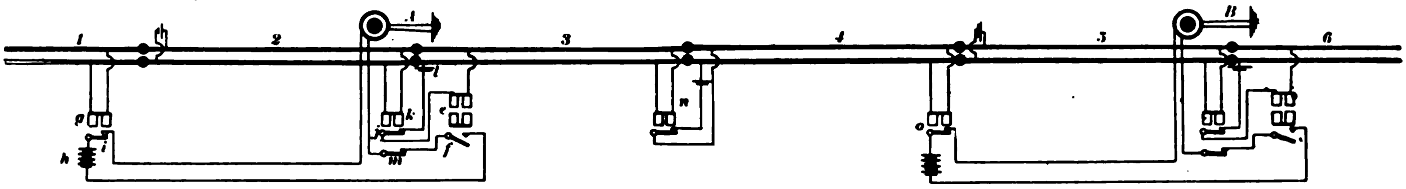

FIG. 42.

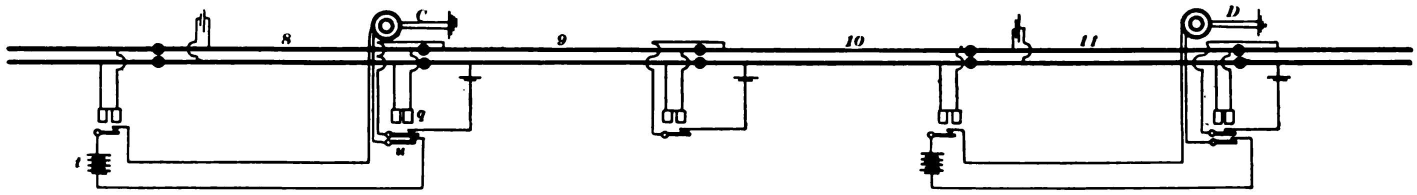

FIG. 43.

In Fig. 41 the resistances of the various relays at section *C* and of the similar relays at the other cut sections are as follows: *a*, 4 ohms; *c*, 16 ohms; *k*, 50 ohms; *j*, 50 ohms, and *g*, 200 ohms. The resistance *i* is equivalent to 75 ohms, and the resistance *e* to 50 ohms. All relays directly connected to the track have a resistance of 4 ohms, and all relays in series with the tracks and track battery 16 ohms. This applies to nearly all the relays in all of the various systems described or to be described.

In Fig. 44 the diagram of connections of the normally clear polarized relay system of home and distant signals on separate masts with overlap is shown. A train, *c*, is supposed to be across the section 6, controlled by signals *A*, *E*, *D* and *F*. Each signal protects one of the sections 1, 2, 3, etc. At the home signals, *C*, *E*, *G* and *I*, the current reversers, *a*, operated by these boards and connected to the track, are shown. On each of the distant, or fish-tail signals, *B*, *D*, *F* and *H*, are shown polarized relays, *d*, which effect the connections in a manner which will be evident from an inspection of the diagram. Since a train is in section 6, the neutral, or current, armature of *d* short circuits the track battery of section 5, and thus holds signal *E* at danger, by depriving the relay at this point of current. The movement of the semaphore at *E* reverses the circuit in the track section 4, and, by moving the polarized armature at the sign *D*, holds the latter at danger by open circuiting its battery.

In Fig. 45 the line method of controlling these overlap signals is shown, a train in this case being at section *e*. The home signal *J* is controlled by the relay at this point which derives current from the battery at signal *K*, line wires connecting the signals *K* and *L*. When the latter signal is in the clear position the circuit is closed at *n*, which thus connects the signal battery at *L* with the latter. The distant signal *O* being at danger, the relay at this point has its armature in the lower position, thus short circuiting the track battery at *L*, and holding the latter in the danger position.

The same means also hold *M* in the caution position. The same connections are used at signals *P*, *Q* and *R*, the two armatures of the relay *f* in this case being in the upper position, and holding both of the signals, *P* and *Q*, in the clear position.

In Fig. 46 a diagram of the circuits employed in the relay method of polarity control is shown. The relay 1 controls the signal *S* through the relay at the latter point. The current reverser *g*, connected to the track through the armatures of the relay at this point, controls the movement of the relay at signal *T*. The relay at *g* is con-

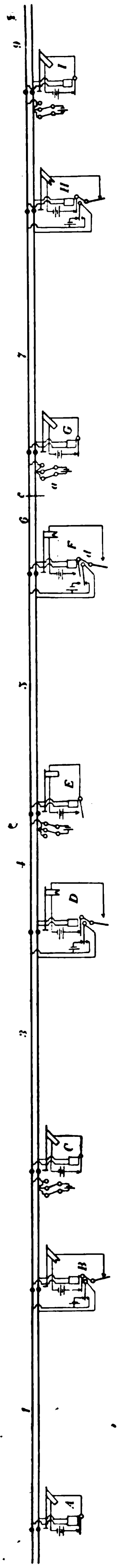

FIG. 44.

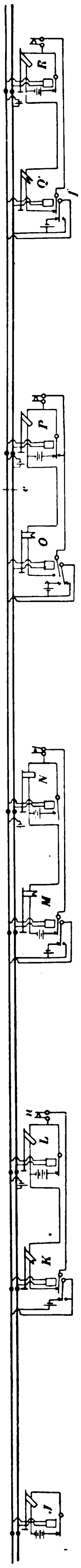

FIG. 45.

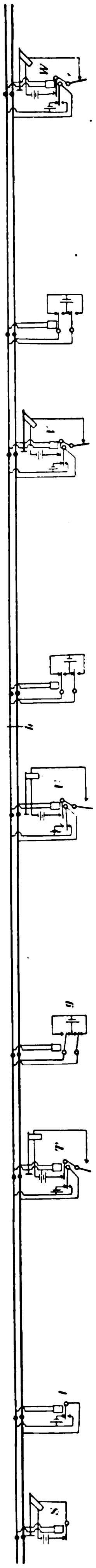

FIG. 46.

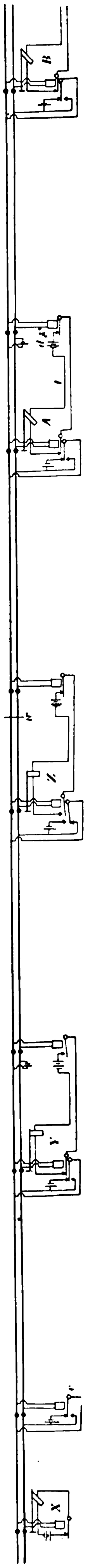

FIG. 47.

trolled by the polarized relay at *U*, which in this case holds this signal in the danger position by having its neutral armature in the lower position, caused by this relay being short-circuited. Signals *V* and *W* are in the clear position for obvious reasons.

In Fig. 47 the circuit arrangement of a normal clear signal, controlled partly by the track circuit and partly by the line wire system, is shown. This system is also an arrangement for overlap signals. A train at *w* holds *Z* at danger, the relay at the latter being short-circuited, which also short-circuits the relay controlling signal *Y*. The signal *A*, and also the signals *Y* and *Z*, have two wires running to the first section which they protect. These line wires, shown at *t*, cover approximately one-fourth of the entire track distance.

In Fig. 48 the arrangement of a normal clear system of home and distant boards on the same mast is shown. The track contains two switches, *E* and *X*, a train being supposed to be in the block protected by the signal, *C*.

It would seem that, since this train is only in the home block of the signal, only the home board should be held at danger; but all double-indication, or double-block signals, have an arrangement of circuit connections such that the distant board is always at the caution position when the home board is at the danger position.

The circuit of the distant board has in series a circuit-closer controlled by the home board. It is in this manner that the distant board assumes the caution position whenever the home board is at danger.

The track relay, *V*, at the signal, *A*, has two normally closed armature contacts, one of which is in series with the home signal magnet, *Q*, and the other in series with the signal magnet, *J*. *J* connects with the common line wire and *Q* with one side of the main battery. The double relay, *Z*, has its lower magnets in series with the track battery and the upper magnets across this track battery, so that both are connected virtually in series with the track battery.

When a train is on the track, the upper magnets are short circuited and the lower fully energized. The armature of this latter relay is connected through the line wire to the switch indicator *I*, causing the latter to assume the clear position when the armature is in the position shown, by connecting this instrument to the common line wire through the signal battery.

The purpose of the switch instrument at the switch *X* is evident from the diagram. The relay *L* has four armatures, which are connected so as to energize the signal magnets when in their upper position, the distant signal magnet being controlled through the circuit closer, operated by the home board of the signal *B*. The second armature of this relay connects, through the line wire *W*, to the lower armature of the relay *K*, thus connecting the battery at signal *C* with the distant board at signal *B*.

The signal magnets *R* and *S* of this signal are connected in a manner similar to that at the signal *B*, the circuit closers *O* and *T* in this case being open, due to the position of the disks at signal *C*. At *D* a home signal only is shown; the track relay *N* being provided, in this case, with three contact armatures, the upper of which, *P*, controls the signal magnet, the contact of the compound track relay *M* controlling the indication of the switch instrument *H*. The switch instrument at *E* is provided with short circuiting contacts *F* and also with the circuit closer *G* connected to the common and indication lines wires.

A diagram of the means employed in electric locking is given in Fig. 49. The relays 1, 2, 3 and 4, with the contact carrying armatures, *a*, control the current passing through relay 8. When 8 is energized, its armature *d* causes the energizing current from battery *e* to continue to pass through it, if the circuit closers at *C* are not open, which will not be the case if any conflicting routes are set up.

If any of the relays, 1, 2, 3 and 4, are short circuited, or de-energized by open circuiting, *d* will still be held in its upper position, but the slot, or indicator, relays, 5, 6 and 7, will be de-energized, thus allowing their armatures *b* to drop and lock the conflicting routes, or else give indication of such confliction.

The Union method of signal control is shown diagrammatically in Fig. 50. This figure shows the connections of the various accessories of the signal *AB*, which has both distant and home boards, an explanation of the operation of the latter only being given in this description. The home board protects the signal block on the rear of the insulating joints *U*, section *X* (along which a train is supposed to be passing) forming part of the block protected by the signal immediately preceding the signal *A*. The connection of the relay *Q*, however, is supposed to be at the end of this latter block.

This relay is of the polarized type, and has two armatures, *X* and *S*. The former is known as the polarized armature, the direction of its movement depending on the polarity of the current passing through

Q and the movement of the armature *S* being controlled by the continuation of cessation of current through its coils. All the apparatus, except that connected directly to the signal *AB*, is located at the signal immediately preceding *A*.

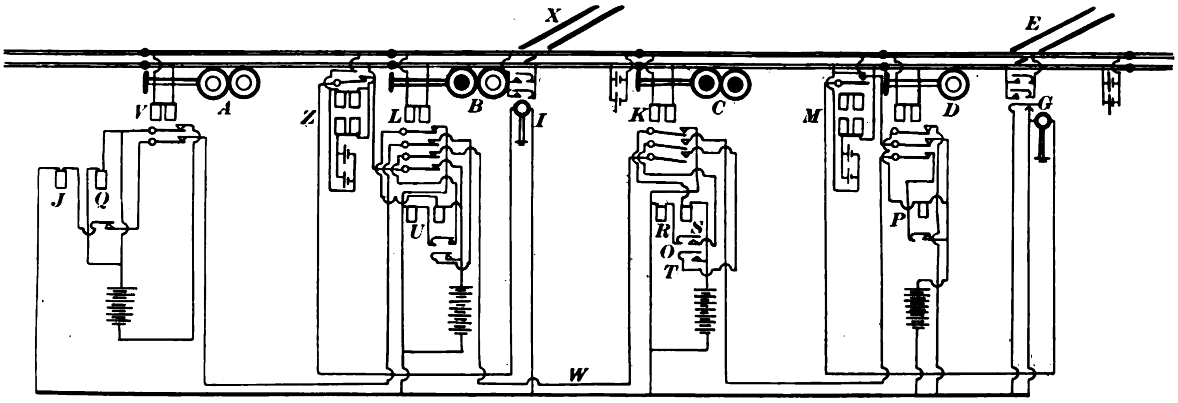

FIG. 48.

This apparatus consists essentially of the motor *E*, placed at the base of the signal, the signal battery *G*, operating the signal, the slow releasing relay *I*, the track relay *Q*, and the slot magnets *K* and *L*.

Suppose that the train passes the signal *A;* this will cause the home arm to move to the danger position, and reverse the polarity of the track battery *C*, connected to this end of the block *X*.

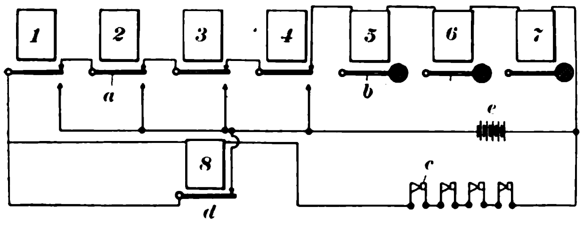

FIG. 49.

This is effected as shown diagrammatically through the rod *F* and the current reverser *D*. As soon as the train has passed out of the block *X*, the neutral armature *S* is raised by the relay *Q*, thus making contact. This connects one side of the battery *G* with one side of the slow releasing relay *S*, thus sending a current from the other side of the battery through this relay. This causes the armature *H*, pivoted at *T*, to make contact with *P*, thus connecting one side of the battery to the binding post 1, the other side of the battery being connected to binding post 3.

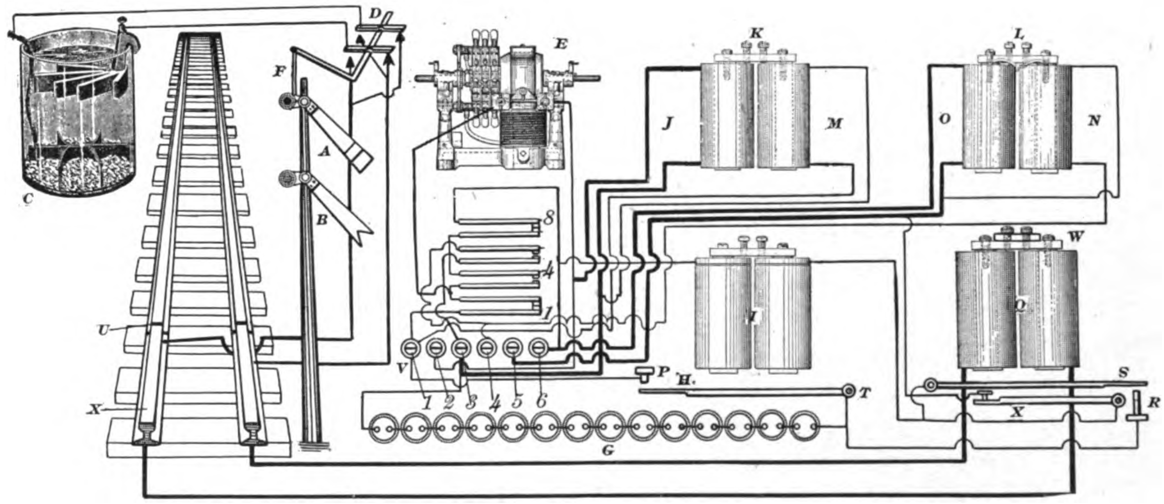

FIG. 50.

The contacts 1 to 8 are operated as follows: 1 and 2 are closed when the home signal of this signal moves to danger; 3 and 4 are opened, 5 and 6 being also opened, while 7 and 8 are closed by the operation of the distant signal.

The signal slot magnets *K* and *L*, the former on the home signal and the latter on the distant signal, have each two windings, one of high resistance and the other of low resistanhce. The reason for these two windings is as follows: Since a small number of cells of battery for each signal are used, and owing to the low voltage of each cell, the signal motors are of a very low resistance, and require a very heavy current for their operation, especially at the start, when the counter voltage of the motor is very low. This heavy current discharge causes the battery voltage to drop considerably, which decreases in a very marked manner the current energizing the slot magnets.

It is for this reason that they are compound wound, the series winding carrying the heavy current taken by the motor, thus giving the magnets a high degree of magnetization. This renders unnecessary a separate battery for slot magnet operation.

The slot magnets are normally continually taking current when the signal is in the clear position through the high resistance winding.

The purpose of the slow release magnet *I* is as follows: When the polar armature of the track relay is shifted by the reversal of track circuit, the neutral arm releases and almost immediately returns. The home signal is controlled through the armature of this relay *I*, which has a very high self-induction and thus prevents the immediate release of its armature.

Motor *E* is connected to the second binding post and also to the first, through contacts 1 and 2 operated by the home board. This motor thus derives current through the armature *H* of the relay *I* and through the lower resistance winding of the slot magnet *K*. The rest of the circuit relations may be readily traced up through the diagram.

◆

Extensive Electric Traction—The New York, New Haven & Hartford Railroad Company has begun work on its new proposed six-track electric rapid transit system from New Rochelle to the Harlem River. Property has been purchased east of the tracks at New Rochelle, where a station will be erected. Already the work of constructing a subway under the tracks has been begun. A corps of engineers, surveyors and contractors who will be in charge of the work have opened offices at New Rochelle.

THE LAY-OUT AND CONSTRUCTION OF A MODERN SUB-STATION

BY S. O. SWENSON.

In modern central station systems distributing electricity for light and power purposes in large cities, the sub-station plays a prominent part. It has made possible the economical generating of electricity in large power stations from which current is transmitted at a high potential and converted, in the sub-station, to a lower potential suitable for light and power work.

The design of the Ohio Street sub-station of the Chicago Edison Co., which has been made the subject of this article, may be considered as a recent solution where real estate is provided, and where provision for extensive future growth is made.

This sub-station feeds the mains of an Edison three-wire system, interconnected from one end of the city to the other, and is laid out for four 1000-kw. rotary converter outfits, which include four 1100-kw., three-phase, air-blast transformers; four 88-kw., air-blast regulators, and four 1000-kw., 250-volt, rotary converters, with the necessary high and low-tension switches; one 1428-ampere, 70-volt, three-unit booster set, and a storage battery consisting of 150 type "H" tanks, each containing 49 "H" plates, with the necessary switchboards and auxiliary apparatus. The storage battery was manufactured by the Electric Storage Battery Company, and has a rating of 960 amperes for 8 hours and 3840 amperes for one hour.

The lot is 50 ft. wide by 100 ft. deep, located in the middle of a block in a manufacturing district about a quarter of a mile from the present electrical center of distribution. It is expected that during the next year or two a large power load will be con-

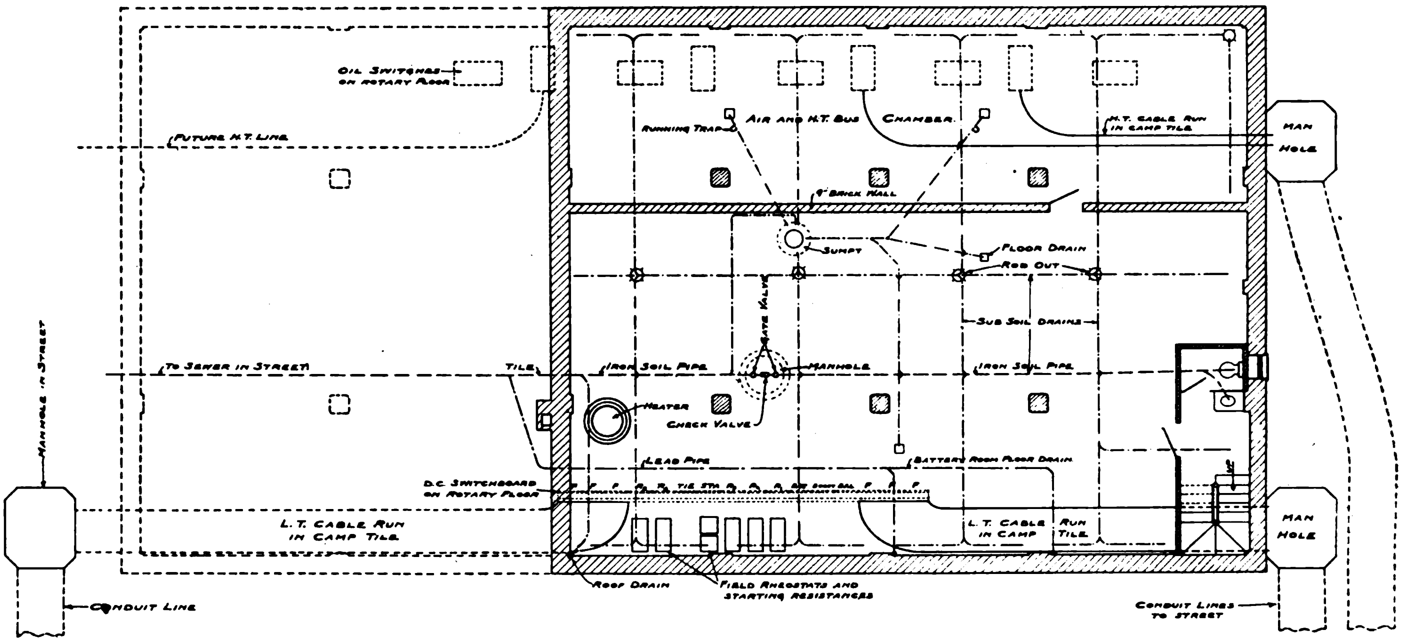
Oil Switches on Rotary Floor
Future H.T. Line
Running Trap
Air and H.T. Bus Chamber
H.T. Cable Run in Camp Tile
Man Hole
9" Brick Wall
Sump
Floor Drain
Rod Out
Sub Soil Drains
Manhole in Street
To Sewer in Street
Tile
Iron Soil Pipe
Gate Valve
Manhole
Iron Soil Pipe
Heater
Check Valve
Lead Pipe
Battery Room Floor Drain
D.C. Switchboard on Rotary Floor
L.T. Cable Run in Camp Tile
L.T. Cable Run in Camp Tile
Man Hole
Roof Drain
Field Rheostats and Starting Resistances
Conduit Line
Conduit Lines to Street

FIG. I.—GENERAL PLAN OF SUB-STATION BASEMENT.

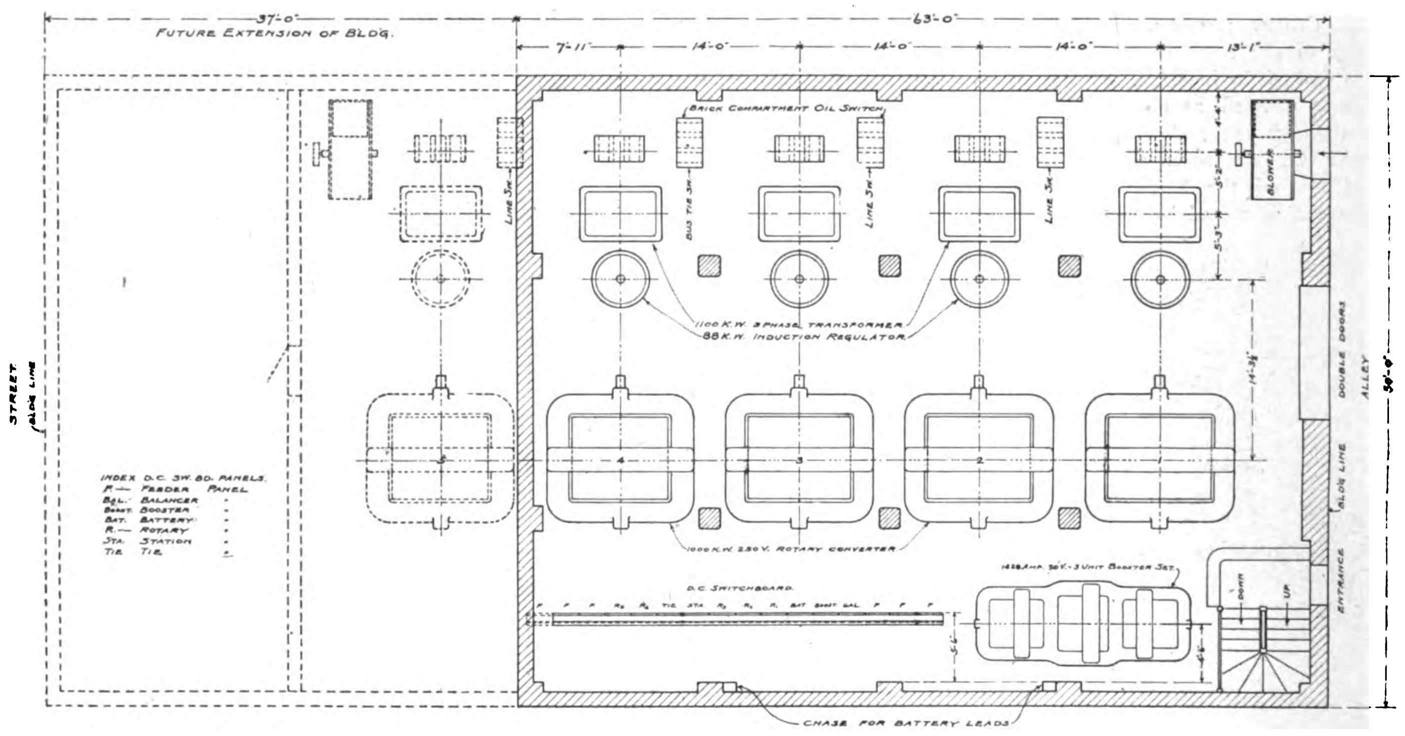
37'-0"
Future Extension of Bldg.
63'-0"
7'-11"
14'-0"
14'-0"
14'-0"
13'-1"
Brick Compartment Oil Switch
Line Sw.
Bus Tie Sw.
Line Sw.
Line Sw.
Blower
1100 K.W. 3 Phase Transformer
88 K.W. Induction Regulator
Street
Bldg Line
Index D.C. Sw. Bd. Panels
F.— Feeder Panel
Bal. Balancer
Bst. Booster
Bat. Battery
R.— Rotary
Sta. Station
Tie Tie
4
3
2
1
1000 K.W. 250 V. Rotary Converter
1428 Amp. 70 V. 3 Unit Booster Set
D.C. Switchboard
Double Doors
Alley
Bldg Line
Entrance
Down
Up
Chase for Battery Leads

FIG. 2.—PLAN OF ROTARY CONVERTER FLOOR IN SUB-STATION.

tracted for in the surrounding district, thus bringing the electrical center of distribution nearer to the sub-station. The property being in a manufacturing district, the cost is high, and so from a commercial standpoint it should be made a paying investment as well as the sub-station itself.

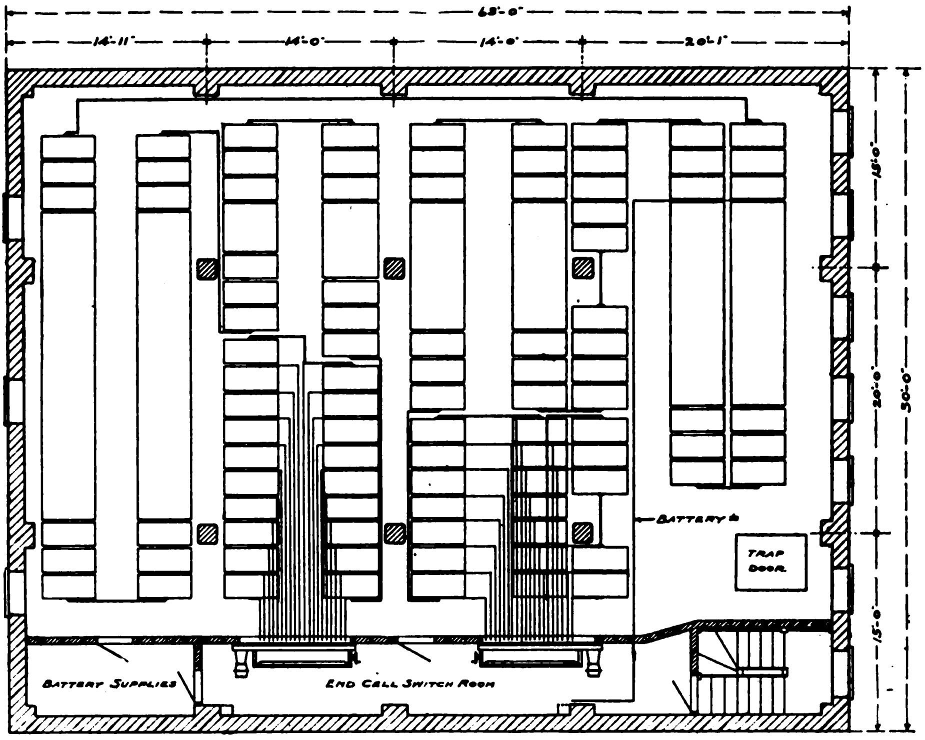

FIG. 3.—GENERAL PLAN OF THE BATTERY ROOM.

In order to minimize the present investment in building and at the same time allow the greatest possible latitude for the design of the ultimate building, it was decided to locate the present portion on the rear of the lot, as shown in Fig. 12, which was taken from the alley side and shows several of the large manufacturing buildings in the background. It it thus possible to erect such a structure on the front of the lot as future conditions may warrant and at the same time reduce the unproductive investment for the present.

The foundations and steel construction of the sub-station are sufficiently heavy for an eight-story building, the plans for the future being to build toward the street and upward. That portion in front of the sub-station might be used by the company for the installation of the fifth 1000-kw. rotary outfit, a high-tension switching center, customers' supply room and a main entrance to building, while the upper floors can be rented for manufacturing purposes.

Fig. 1 shows the general plan of basement, with future extension of building shown dotted; location of cable runs, feeder manholes, field rheostats, starting resistances, high-tension bus and air chamber, toilet room and drainage system. Fig. 2 shows the general plan of rotary converter floor, with center line dimensions of apparatus, and outside dimensions of building. Fig. 3 shows a general plan of battery floor, location of tanks, end cell switches and series and end cell copper connections. Fig. 4 shows a section through the building, looking north, and gives the general arrangement of the sub-station with copper connections and cable runs.

Referring to Fig. 4, it will be seen that the battery room is on the second floor and hence requires very heavy steel construction to sustain the load which is approximately 200 lbs. per sq. ft. for the entire area of the battery room. By having the battery room on the second floor the basement is free for all cable runs, high-tension bus and air chamber, mounting field rheostats, starting resistances, a heating system and a well-designed drainage system which would be impracticable were the battery in the basement as is often the practice.

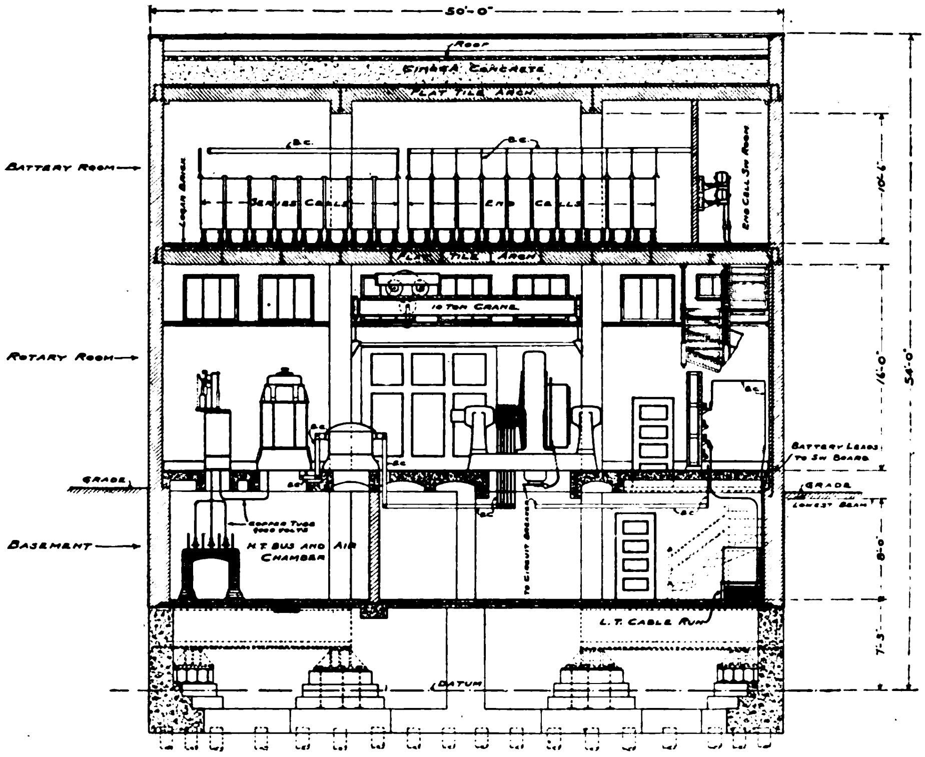

FIG. 4.—SECTION THROUGH SUB-STATION BUILDING.

It will also be noted that starting with the high-tension bus bars, which are two bars of 1½ in. by ⅜ in. copper, copper tubes are used as conductors to the oil circuit breaker, and also to the primary terminals of the transformers. These high-tension conductors are insulated with oiled linen and asbestos tape, the bus bars in addition being wrapped with cord.

From the secondary terminals of the transformer bar copper is used to the regulator and also from the regulator to the rotary converter and from the rotary converter to the direct-current switchboard, hence the only cables which are installed are the incoming high-tension lines, the battery cables from the end cell switches to the direct-current switchboard and the outgoing feeders. Further, it will be noted that the end cell switches are directly over the direct-current switchboard, thus requiring only a short run of battery cables.

Fig. 8 shows the relative location of the rotary converter outfit and direct-current switchboard. In the foreground a railing is built around the floor opening for a future machine; the crane shown is of ten tons capacity, hand operated; the brick compartment oil switch shown on the extreme right is the 9000-volt oil circuit-breaker for this unit. Approximately 6 ft. clearance is left between the rotary converter and the regulator which gives a liberal aisle the entire length of the sub-station and allows any part of a converter or transformer to be carried by a crane beyond units already installed.

One of the points requiring consideration in laying out a sub-station is the lighting. The circuits should be run in iron conduit and the number of lights for the rotary room and basement should be such as to give good general illumination, with plenty of wall outlets for extension cord lamps or light power circuits in case of emergency. In the battery room, however, more lights should be provided than is usually the case and these should be arranged so that they come in the center of aisles and on sufficiently close centers, to allow a thermometer or hydrometer to be read in each tank without using a drop lamp.

Fig. 5 which shows the high-tension lines for the entire Edison and Commonwealth systems in Chicago, indicates a method frequently used for providing two or more separate lines from the high-tension transmission system for each sub-station, i. e., either by a direct line or by a tie line which gives it a back feed through some other sub-station. The high-tension lines are protected by three overload relays, which are operated by series transformers on each phase of the line and are set to operate at a certain overload depending upon the location of the sub-station with respect to other sub-stations fed by the same line. The relays in turn close a tripping circuit on the control switch which operates the line oil circuit-breaker.

In case of trouble on the alternating-current side between the rotary oil circuit-breaker and the rotary converter there would be two direct feeds to the trouble; one from the high-tension line or lines, the other from the rotary converter. Should trouble develop, the direct-current system and battery, which floats on the system, would feed back through the converter and hence give alternating-current energy to the short.

The line or lines would be cut off at a certain predetermined overload. The machine would be cut off at 20 per cent reverse current, since the ammeter needles on the positive and negative sides of the rotary leads are equipped with platinum tips which close a circuit through relays which in turn close a circuit through the direct-current circuit-breaker and thus cut the machine free from the direct-current system. The rotary converter is also equipped with a mechanical speed limit device which closes a circuit through the circuit-breakers at 25 per cent excess of normal speed.

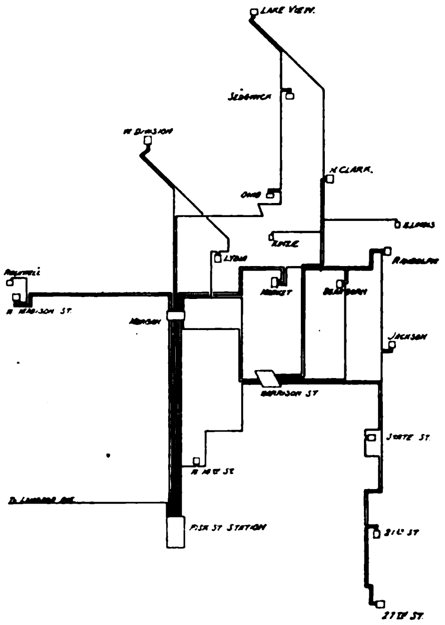
Lake View
Sedgwick
N. Division
N. Clark
Ohio
Illinois
Kinzie
Market
Dearborn
Randolph
W. Madison St.
Jackson
Harrison St.
State St.
Fisk St. Station
31st St.
27th St.

FIG. 5.—9000-VOLT LINES OF THE CHICAGO EDISON AND COMMONWEALTH ELECTRIC LINES.

The general diagram of connections for the complete installation of five 1000-kw. rotary converters is shown in Fig. 6. Starting with the high-tension bus bars there are two direct lines and one tie line to another sub-station, which would be used ordinarily as a feed to the other sub-station, but in case of trouble, on either of the other two lines, would be used as a back feed. The high-tension bus tie switch should be provided with some form of interlocking device so that the operator cannot get the closing circuit for the oil circuit-breaker until he has tested for synchronism.

The primaries of the transformer are delta connected and the secondaries diametrically. The neutral tap of the secondary winding is tied to the neutral of the direct-current system and thus providing a path for the unbalanced load.

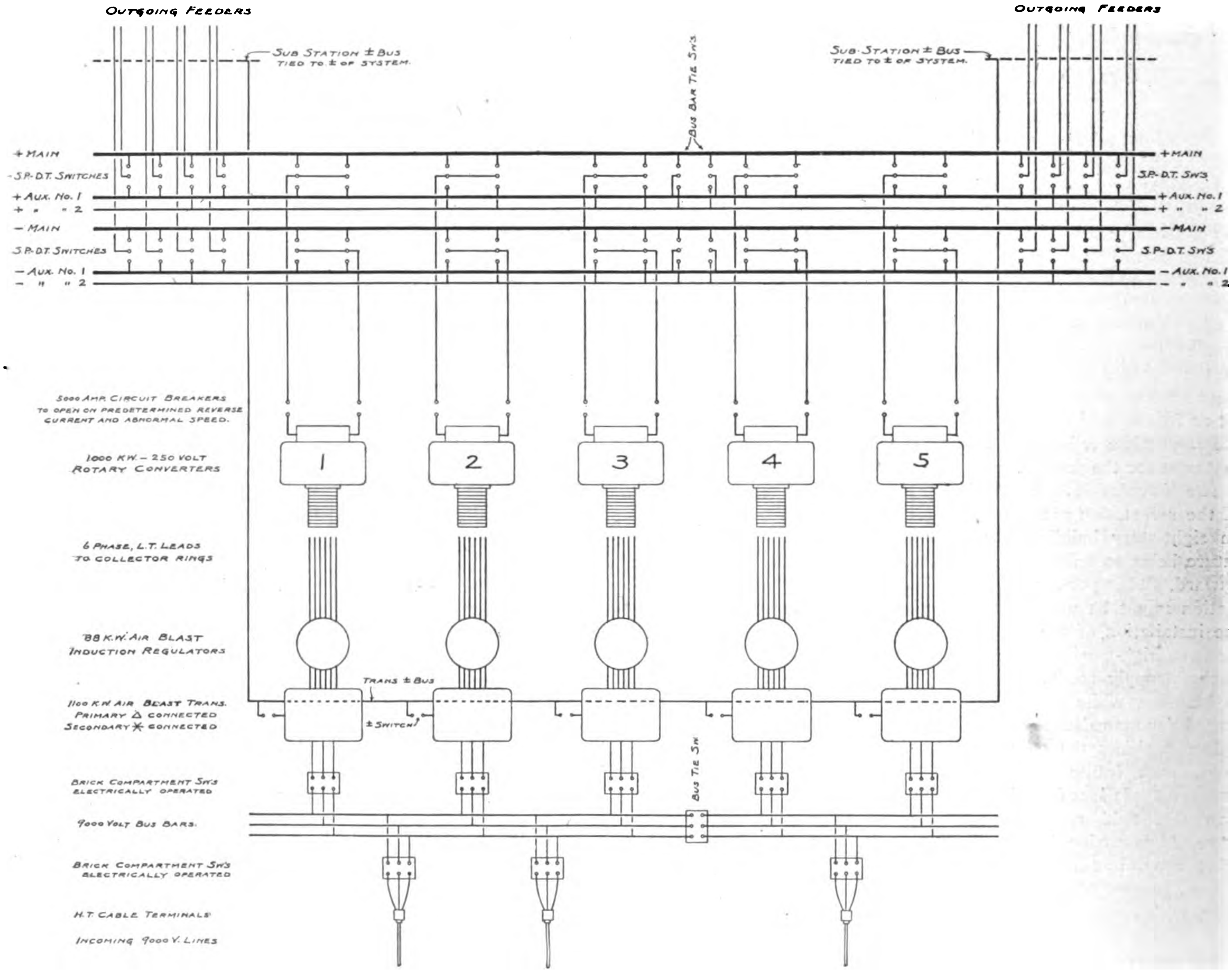
Outgoing Feeders
Sub Station ± Bus tied to ± of System
+ Main
- S.P.-D.T. Switches
+ Aux. No. 1
+ " " 2
— Main
S.P.-D.T. Switches
— Aux. No. 1
— " " 2
Bus Bar Tie Sw's
Outgoing Feeders
Sub-Station ± Bus tied to ± of System
+ Main
S.P.-D.T. Sw's
+ Aux. No. 1
+ " " 2
— Main
S.P.-D.T. Sw's
— Aux. No. 1
— " " 2
5000 Amp. Circuit Breakers to open on predetermined reverse current and abnormal speed.
1000 KW. – 250 Volt Rotary Converters
1
2
3
4
5
6 Phase, L.T. Leads to Collector Rings
88 K.W. Air Blast Induction Regulators
Trans ± Bus
± Switch
1100 K.W. Air Blast Trans. Primary Δ connected Secondary ✳ connected
Bus Tie Sw
Brick Compartment Sw's electrically operated
9000 Volt Bus Bars.
Brick Compartment Sw's electrically operated
H.T. Cable Terminals
Incoming 9000 V. Lines

FIG. 6.—GENERAL DIAGRAM OF CONNECTIONS FOR ROTARY CONVERTERS.

The regulator shown is an 88-kw. induction regulator by means of which the direct-current voltage can be raised or lowered approximately 10 per cent.

As shown in Fig. 8 and also in the view taken underneath the converter (Fig. 9), the direct-current circuit-breakers are mounted on the alternating-current end of the machines. This end was selected because all the free space on the direct-current end is needed for the proper attention of brushes and commutator. The view taken underneath the converter also shows the opening through the floor and the copper connections at machine. The copper connections shown in the center of the right side of the engraving, come from the regulator and tie to the alternating-current terminals of machine. The copper connections from terminal blocks on either side are shown going up to circuit-breakers and thence to the direct-current switchboard. The cables tie from the collector rings to the terminal blocks.

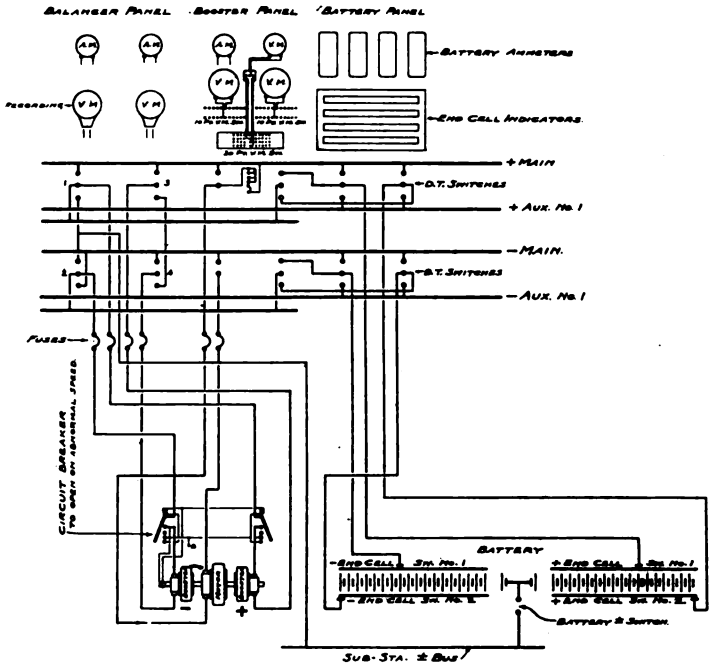

FIG. 7.—GENERAL DIAGRAM OF BATTERY AND BOOSTER CONNECTIONS.

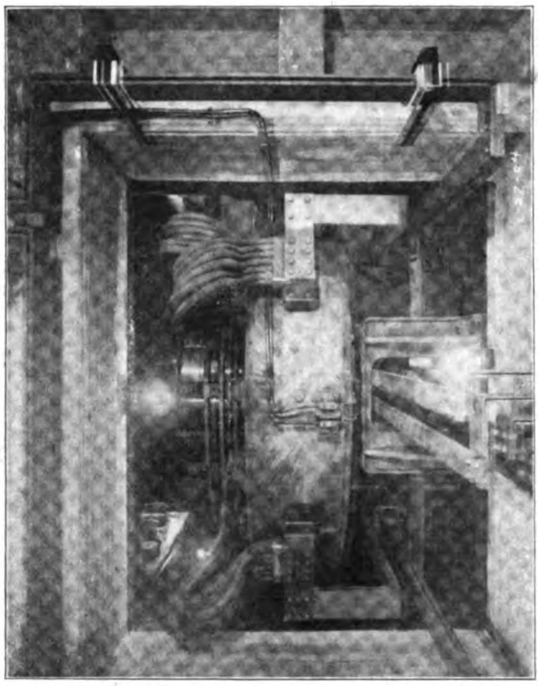

FIG. 9.—VIEW FROM BELOW ROTARY CONVERTER.

The direct-current switchboard is shown on the left side of Fig. 8; the panels from left to right being as follows: Feeder panels, balancer, booster, battery panels, rotary panels and station panel. Each feeder panel is arranged for four feeders, each feeder having one + ammeter, one — ammeter, one single-pole, double throw positive switch and one single-pole, double-throw negative switch arranged one above the other. The rotary panel is equipped as follows: One power factor indicator, one integrating wattmeter, one positive direct-current ammeter, one negative direct-current ammeter, two reverse current relays, one synchronizing switch, one regulator control switch, one oil circuit-breaker control switch with pilot lamps, which are connected to show green when oil circuit-breaker is open, and red when closed, two 2500-ampere switches, in parallel on positive side and the same for the negative side of rotary direct-current leads, starting switch with fuse extension in series with main starting switch and field switches with carbon break and discharge clips. The station panel contains a Lincoln synchronizer, alternating-current voltmeter and point switch, control switches with pilot lamps for line and bus tie oil circuit-breakers and main starting switches. The tie panel contains the potential indicators for recording bus and feeder pressures and the bus bar tie switches. The balancer, booster and battery panels are equipped as shown in Fig. 7, which shows the general diagram of connections for the battery installation. The end cells are equipped with two end cell switches on each side of the battery, hence can be charged and discharged simultaneously or discharged on two sets of bus bars at different potentials at the same time.

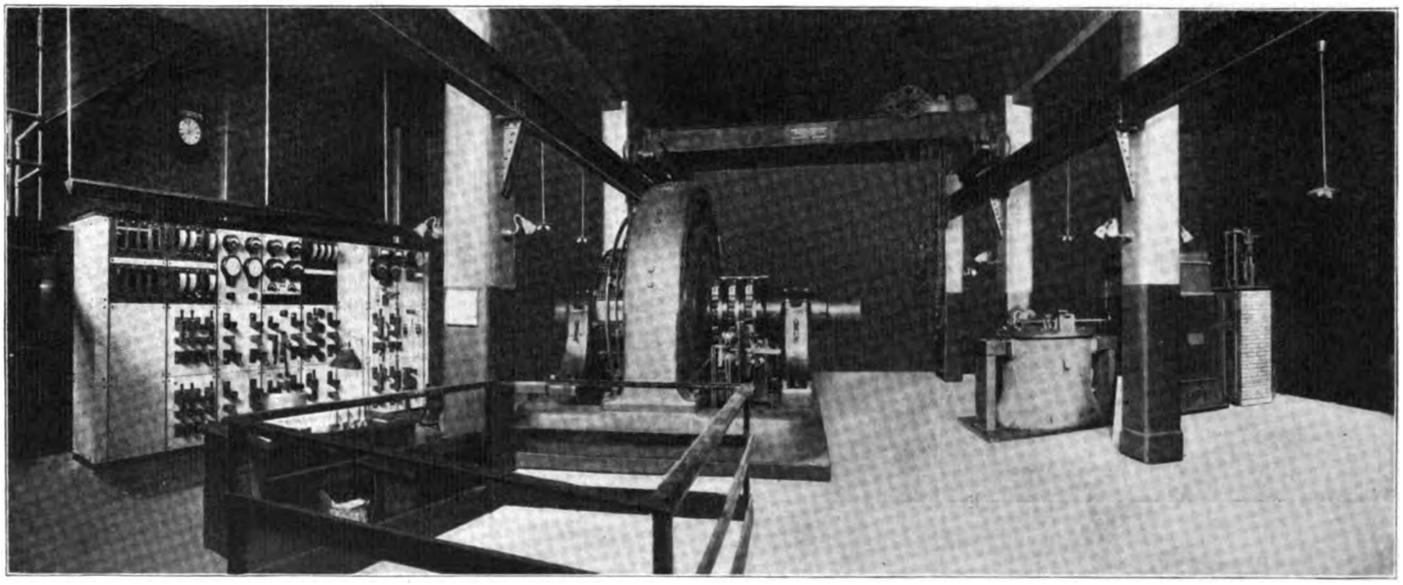

FIG. 8.—VIEW OF CONVERTER ROOM IN OHIO STREET SUB-STATION.

In order to indicate the position of each end cell switch at any time an annunciator system was installed, one annunciator drop being provided for each position of each end cell switch, thus doing away with the complicated system of gearing which was previously used with mechanical indicator.

The general arrangement of the bus bars, outgoing feeders, copper connections and space between switchboard marble and iron frame is shown in Fig. 10, taken from the rear of the switchboard. The marble is spaced 6½ in. from the iron frame by means of cast-iron spacers, the space being used for pressure busses, starting bus, discharge bus and any small conductors which cross the panels.

The arrangement of busses is as follows: At the top is the + main; next is the + auxiliary No. 1; next is the — main and at the bottom is the — auxiliary No. 1. Auxiliary bus No. 2 is not installed at present, but will be installed on the same brackets as auxiliary No. 1, being in back of same, with proper clearance; hence to change any feeder, battery or rotary from auxiliary bus No. 1 to auxiliary bus No. 2 merely means a longer tie from the switch stud to bus bars.

The switches are so arranged that the positive switches are on the top row and negative on the bottom and are so connected that when they are thrown up they tie to the main bus and when thrown down, to auxiliary No. 1 or auxiliary No. 2, depending upon the tie which is installed; thus with the three sets of bus bars three potentials can be maintained for feeders which can be fed as follows: Main bus entire capacity of sub-station, auxiliary bus No. 1 storage battery and three converters, auxiliary bus No. 2 two converters.

As there are no means of balancing the load, the three-unit booster set is connected so that the unbalance on either side of the system can be taken care of. This is done in the following way: To balance on the positive side close switches No. 1 and No. 2 up, No. 3 and No. 4 down, as shown in Fig. 7, and to balance on the negative side close switches Nos. 1, 2, 3 and 4 down. As the high-tension bus bars are installed in the basement it is very important to keep the basement dry and in order to prevent seepage of water into the basement a damp course was laid in the basement floor and through foundation walls consisting of three layers of tarred roofing felt. The foundation walls from the damp course to grade are cemented and tarred; as a further protection sub-soil drains are laid beneath the basement floor to carry off any surface water which may accumulate.

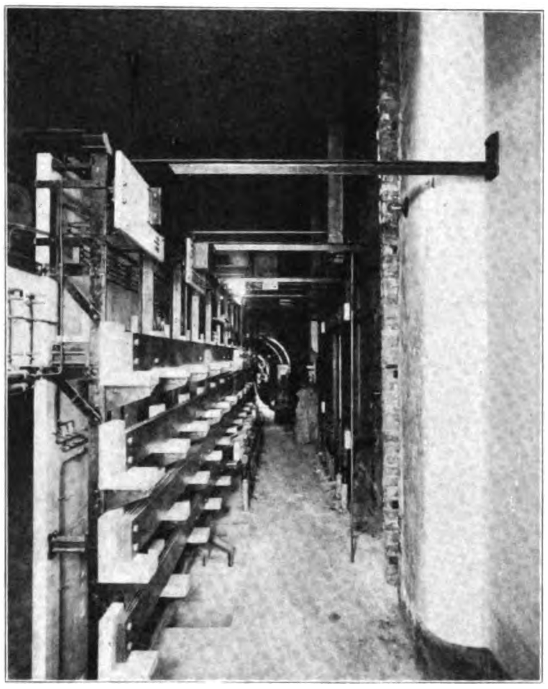
FIG. 10.—REAR VIEW OF SWITCHBOARD.

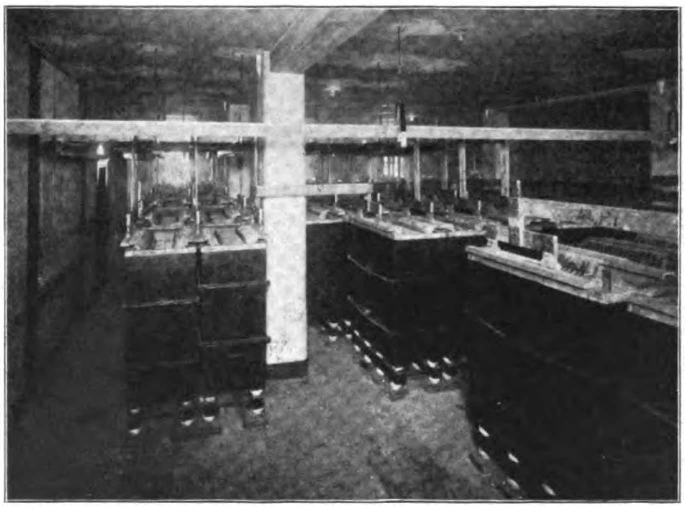
FIG. 11.—STORAGE BATTERY ROOM.

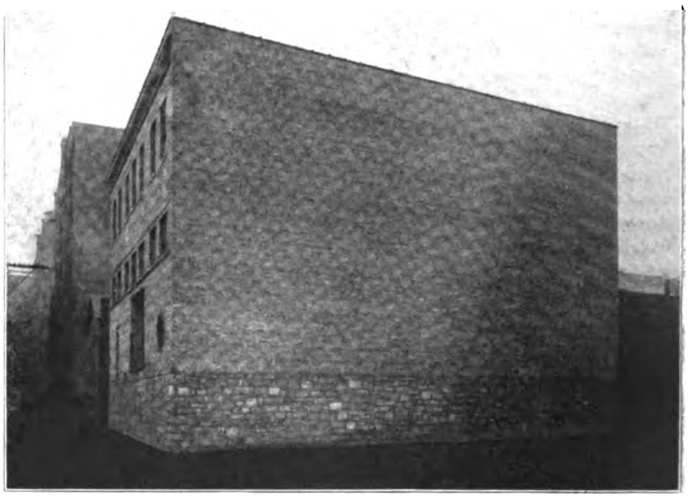
FIG. 12.—EXTERIOR VIEW OF SUB-STATION.

In order to prevent danger of back water from street sewer a check valve is placed in the building between two gate valves which are installed so that, in case the back-water valve fails to close, the sewer can be cut off and the back-water valve repaired.

Where it is advisable, depending upon the location of sub-station and general conditions, to spend more money on the finish of the building, the floor of the rotary room should be some form of encaustic tile or other non-absorbent material; but where it is not deemed expedient to have a tile floor, cement floors have proven very satisfactory, provided the cement is carefully laid and troweled down to a smooth, hard finish and lined off into squares in order to prevent unsightly cracks.

The framing for the rotary room floor should be laid out so as to give an opening under each machine of suitable dimensions for giving the machine a maximum natural ventilation and hence increasing its capacity. An opening to the outside should be provided for the blower intake which should be constructed so as to have two dampers, one to close the outside opening and the other to close the opening to the sub-station; hence, it is possible to take any proportion of air from outside and inside, depending upon the condition of the atmosphere in the sub-station and outdoors.

The view of the battery room, Fig. 11, shows the arrangement of tanks and copper connections. It will be noted that the tanks are supported by a double tier of insulators; this precaution was found necessary due to leakage from tanks to ground. The double row of insulators have proven very effective and afford more space for cleaning and inspection. All supports and copper connections are lead-coated and as an additional protection against the acid fumes, are covered on top with sheet lead. The battery room floor is made of Logan brick, which is a vitrified, hard-burned brick with all sides thoroughly glazed. It might not be amiss to add here a few notes on battery rooms in general.

In a number of battery rooms recently installed the floor construction is as follows: First, a layer of concrete is laid over a tile arch and floor beams and given a cement finish, which, when dry, is thoroughly mopped with hot asphaltum; the bricks are then laid with about 1-16-in joints, which are filled with hot asphaltum, thus making an acid-proof floor.

A cement base is provided on all walls and columns are protected by a lead base, all joints of which are burned; the top being turned into the fire-proofing around the columns and the bottom flashed underneath the hard-burned vitrified Logan brick floor.

All plastering in the battery room should be either of adamant or Portland cement, as the acid fumes have an injurious effect upon ordinary lime plaster and soon cause it to flake off. Even where adamant or cement plaster is used it has been found advisable to thoroughly paint it with white lead and oil as a protection against acid fumes.

Provision should be made for sufficient ventilation to carry away the gases given off by the battery during period of charge. In many cases this can be accomplished by installing suitable vents with intakes near the ceiling or in some cases by having ample window space.

Some means should also be provided for heating the battery room either by a heating system or by exhausting the hot air from the rotary room into the battery room. The temperature of the battery room should be kept at not less than 70° F., during the coldest weather, as the capacity of the battery varies materially with the temperature.

The building should be designed so as to conform with insurance regulations in order to obtain the best rate of insurance on building and contents, which is an important item on the fixed charges of a sub-station. In the gradual development of central stations from year to year, it frequently becomes necessary to design and build substations on lots varying from 20 to 50 feet in width. In some cases also the excessive cost of real estate has made it necessary to secure long time leases and install substation apparatus in the basements of large fire-proof buildings.

As the development of sub-stations has introduced an additional link in the chain between the generating unit and customers' service, it is of the greatest importance to make this link effective and reliable.

Abstracts from Foreign Contemporaries

Experiments on Nernst Lamps.—Herr von Gaisberg has communicated to the *Elektrotechnische Zeitschrift* the results of some life and efficiency tests on 110-volt Nernst lamps obtained by the Hamburg Inspectorate of electric lighting. The lamps were taken from stock, being of the type known as the "B pattern," with a straight filament stretched horizontally below the flat zigzag heater. No trouble was experienced with the series resistances, which were designed for 15 volts. During the tests, the lamps were extinguished twice every 24 hours, but switched on again after having cooled down. They were equipped with globes of opal glass and the photometric measurements were made in the axis of the lamps. It is likely that the values obtained in the direction of the axis are not very different from those relating to any point within a cone with an angle of 90° at the apex. The results are given below.

No. of lamps.	Hours of burning.	Mean pres. at lamps in volts.	Consumption in watts.	C.p. in direc. of the axis. (Hef. units).	Consump. per Hefner c.p.	
10	0	111.0	30.7	19.7	1.6	Pattern B, 0.25 a., 110 v.
10	25	109.3	29.8	14.4	2.1	
10	50	110.1	30.5	12.3	2.5	
10	75	109.9	30.0	12.4	2.4	
10	100	109.6	29.5	12.6	2.3	
10	200	109.9	29.5	12.2	2.4	
10	300	109.9	27.8	12.3	2.3	
10	400	110.0	26.7	9.4	2.8	
10	500	112.0	27.1	10.5	2.6	
10	600	110.1	22.3	7.0	3.2	
10	700	110.4	21.5	6.2	3.5	
10	0	110.5	57.4	44.4	1.3	Pattern B, 0.50 a., 110 v.
10	25	112.0	57.4	29.7	1.9	
10	50	109.3	55.8	28.7	1.9	
10	75	110.3	55.5	26.5	2.1	
10	100	109.5	55.5	27.7	2.0	
10	200	109.1	54.6	27.9	2.0	
10	300	109.4	53.4	24.0	2.2	
9	400	110.4	53.7	23.6	2.3	
9	500	111.1	53.1	24.4	2.2	
7	600	11.4	49.3	19.6	2.5	
6	700	110.2	42.7	14.4	3.0	

The Hefner is smaller than our unit of candle-power, the ratio being about 1 to .88.

Improvements in Oil Engines.—The accompanying illustrations (Figs. 1 and 2), taken from the *Mechanical Engineer* of London, give respectively longitudinal and cross-section of an internal-combustion engine, embodying some improvements by A. G. Melhuish. These consist in connecting the suction cylinder by a pipe to a small closed cup, and in fitting this cup with an outlet valve and pipe connected with the vaporizer when oil is used. Also in fitting a valve-controlled inlet pipe from an oil container, the pipe being fitted on a non-return valve. Referring to the suction cylinder *A* is connected by a pipe *B* to a small closed chamber *C* having a cup C_1 formed at the bottom, having an outlet valve *D* and pipe *E* which is connected to the vaporizer *F*. A valve-controlled inlet pipe *G* runs from an oil container *H* to the cup C_1, the inlet pipe *G* having a non-return valve *I* to prevent return of oil. This construction renders the engine effective for using heavy oils, and on the instroke of the suction and working pistons *J* J_1, due to explosion of the charge in the working cylinder A_1, a partial vacuum is formed in the cylinder *A* and pipe *B*, this vacuum acting through the chamber *C*, valve *K*, and pipe *G* on the oil in the tank *H*, and sucks a portion up through the valve *I*, pipe *G*, and valve *K*, and leaves it in the cup C_1. During this action the piston J_1 first uncovers the exhaust port *L*, and in consequence the greater part of the exploded charge escapes, and on a farther travel of the piston J_1 the port *M* will be uncovered, and in so doing the remaining products are sucked into the chamber *N* and suction cylinder *A*, due to the vacuum in same, and at the same time draw in a new combustible charge through the valve *P*. On the return of the piston *J* and J_1, the piston J_1 will first close up the port *M* and

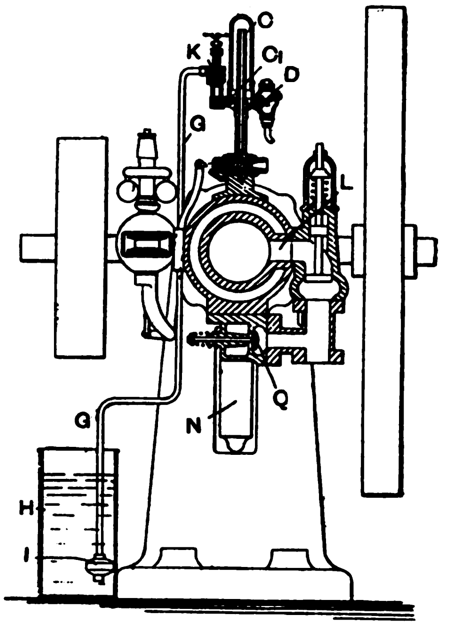

FIG. 2.—CROSS-SECTIONAL VIEW OF OIL ENGINE.

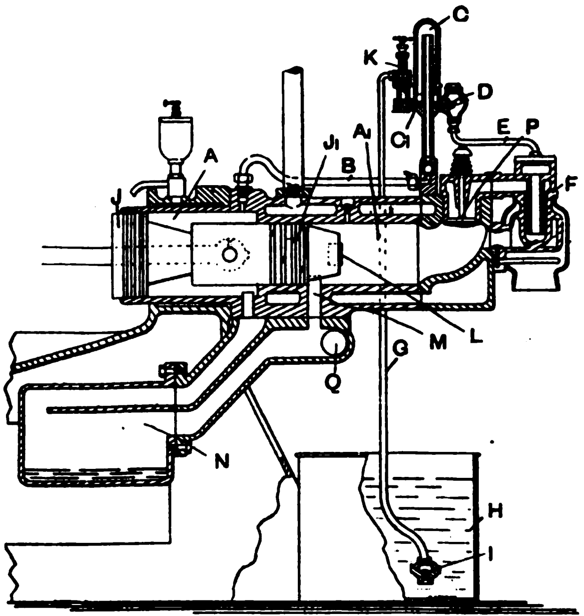

FIG. 1.—LONGITUDINAL SECTION OF OIL ENGINE.

prevent any of the previous charge sucked in the chamber *N* re-entering the explosion cylinder, the piston *J* will drive a portion of the charge which was sucked in the chamber *N* out through the valve *Q*, and also drive the oil previously sucked into the cup C_1 through the valve *P*, pipe *E* to the vaporizer *F*, the piston J_1 at the same time compressing the charge to the firing point for a repetition of the previous cycle.

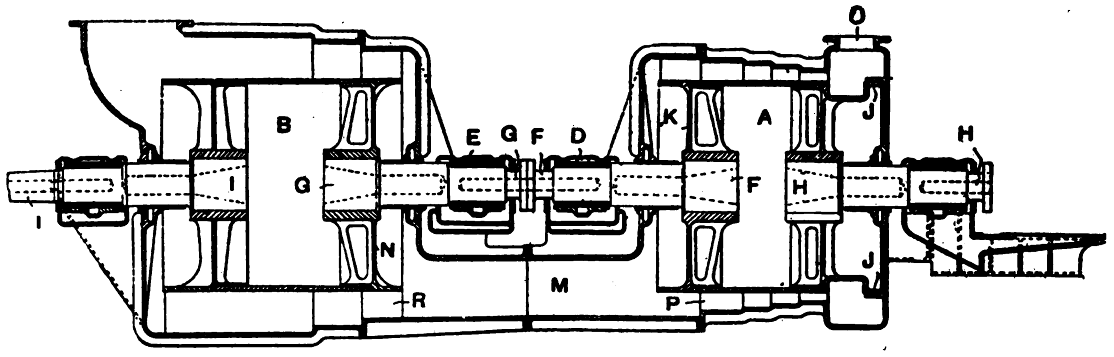

FIG. 3.—IMPROVEMENTS IN STEAM TURBINES.

Improvements in Steam Turbines.—A recent patent granted to Charles Parsons and A. D. Wass, and abstracted in the London *Mechanical Engineer*, relates to the construction more especially of very large turbines, but is also applicable to smaller sizes, the object being to diminish the size of the parts of the turbines by enabling them to be divided into distinct elements generally for placing in series on the steam. The invention consists in dividing up a turbine into two or more parts in tandem on a shaft by interposing external bearings and employing balancing diaphragms not requiring running packings. Referring to Fig. 3 the elements *A* and *B* of a turbine are placed in series on one shaft. Between the two elements the bearings *D* and *E* are placed in which the shafts *F* and *G* rotate. It will be seen that the shaft does not pass the whole way through the drums of the turbine, but is made in parts *F G H I* for convenience of construction. The high-pressure element *A* is provided at the steam inlet end *O* with a dummy piston *J*. At the outlet end *P* of the high-pressure element the turbine drum is closed by a diaphragm *K*, while a passage *M* leads to the inlet side *R* of the low-pressure turbine, the drum of which is closed near the inlet end by means of a diaphragm *N*. The diaphragms *K* and *N* are of the same diameter, and since they are subjected to the same pressure in opposite directions the end balance of the two turbines as a whole is the same as if they had not been divided, and the size of the dummy piston *J* and other parts are regulated by the same conditions as in other forms of Parsons turbines. This arrangement may be applied to turbines arranged in multiple elements on parallel shafts. In such cases each shaft has at least one dummy piston placed at the inlet end of the highest pressure element. The other elements on the same line of shafting have not dummy pistons unless the number of such elements is too great to allow of adequate balancing being obtained by one dummy piston on the highest pressure element.

Automatic Boiler-Feed Regulator.—The accompanying illustrations show a new design of regulator for automatically adjusting the feed supply to steam boilers so as to preserve a constant level in the boiler, which is described in a recent issue of the *Mechanical Engineer* of London. The method of operation will be readily followed from the illustrations. The apparatus is attached to the boiler at *N*, from which water or steam can enter into the tube *F*, according as the opening is below or above the water level. The feed on its way to the boiler passes through the outlet *C* and chamber *D*, and then out at *E* as shown, the object of this circulation being to cool the water from the boiler entering the expansion tube, *F*. So long as the tube, *F*, is open to the steam space in the boiler it remains full of steam, and the feed water in passing through *D* simply gets heated up by its contact with the tube, but the moment the steam supply from the boiler is shut off by the rising of the water level and closing of the passage, *B*, the cold (or partially cold) water surrounding the expansion tube condenses the steam in it and causes the water from the boiler to take its place, and so by partially or wholly filling the tube with water that has been partially cooled down by the feed-water passing through the chamber, *D*, a marked difference is effected between the temperature of the tube when full of steam and extended, and when full of water and contracted. When the water level drops below the line *O* (say to *N*), the water in the tube *F* runs out by gravity, and being replaced with steam is thereby expanded and extended to its full length. This extension relieves the rods *G* and G^1 and the lever, *H*, and by so doing allows the pull of the spring *I* to act upon the lever *J* (the pressure of which on the rod *K* has been relieved by the easing off of the lever *H*), thereby pushing down and closing the by-pass valve *L*. On the other hand, when the water level rises and water rises in the tube *F* and contracts it, the pressure on the rods *G* and G^1 depressees the lever *H* and rod *K* by relieving the spindle of the valve *L* of the pressure of the spring *I* (by the depression of the lever *J*), and leaves the by-pass valve *L* free to open.

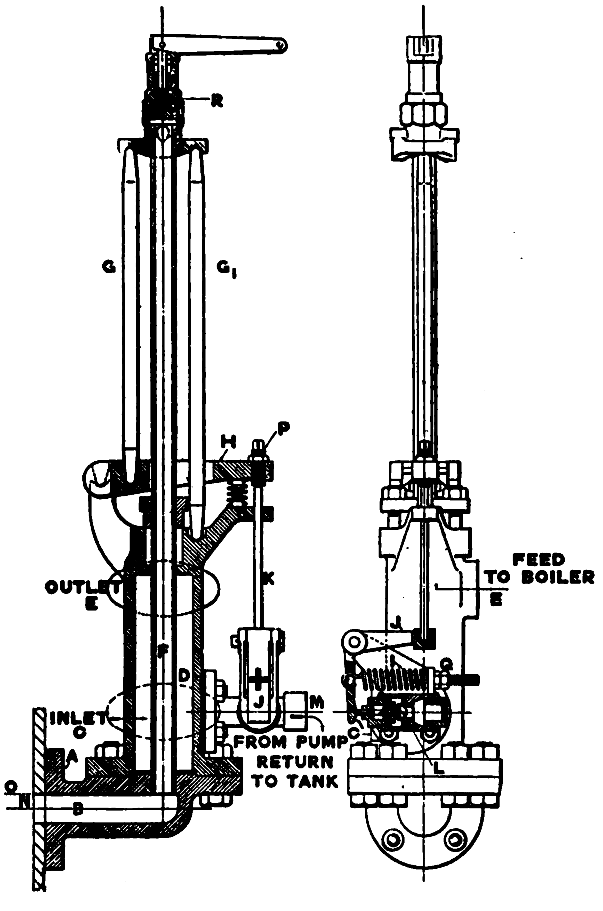

FIG. 4.—AUTOMATIC BOILER FEED REGULATOR.

A Water-Seal Steam Trap.-The accompanying illustration shows a new water-seal steam trap brought out in England and described in a recent issue of the London *Engineer*. The apparatus consists of a head, *A*, with an inlet and outlet the same diameter as the main steam pipe, so that it can be inserted at any point in that line. There are also two baffle plates, *B* (see Fig. 6), which form part of the casting, having two drain holes at the bottom. At one side of the head is a casting forming the discharge valve. The construction of this can be readily seen from Fig. 5. Screwed into the head, in a vertical position, is the sensitive tube, which is made of gun-metal. The diameter of this tube is never less than that of the main steam pipe. Attached to the lower end of the sensitive tube is the spherical water-seal trap. Two steel rods *C* are screwed into lugs cast on to this portion, and are of such a length that they just touch the lever *D* at a distance from the fulcrum equal to one-ninth the length of the lever. By this arrangement any upward movement of the rods *C* will lift the discharge valve *F*. A pipe runs from the discharge valve connection at the top of the head, through the sensitive tube, nearly to the bottom of the trap. Wet steam and water pass along the main pipe, and enter the apparatus at *A;* water then passes into the trap through the recess in the baffle plate. The water which is carried on in suspension passes through an area larger than that of the steam pipe, and further separation results. This water drops into the trap by gravity, and dry steam passes along. The apparatus is therefore a separator as well as a trap. The water-seal chamber gradually gets full of water, which then creeps up the sensitive tube. This water, coming in contact with the gun-metal, slightly cools it, and contraction takes place. The rods *C* are thereby raised, and the discharge valve opened. Water immediately flows up the discharge pipe and through the valve. By this means the water soon leaves the sensitive tube, and is replaced by steam. The temperature rises, the tube expands again, and the valve is consequently closed. This cycle is then repeated.

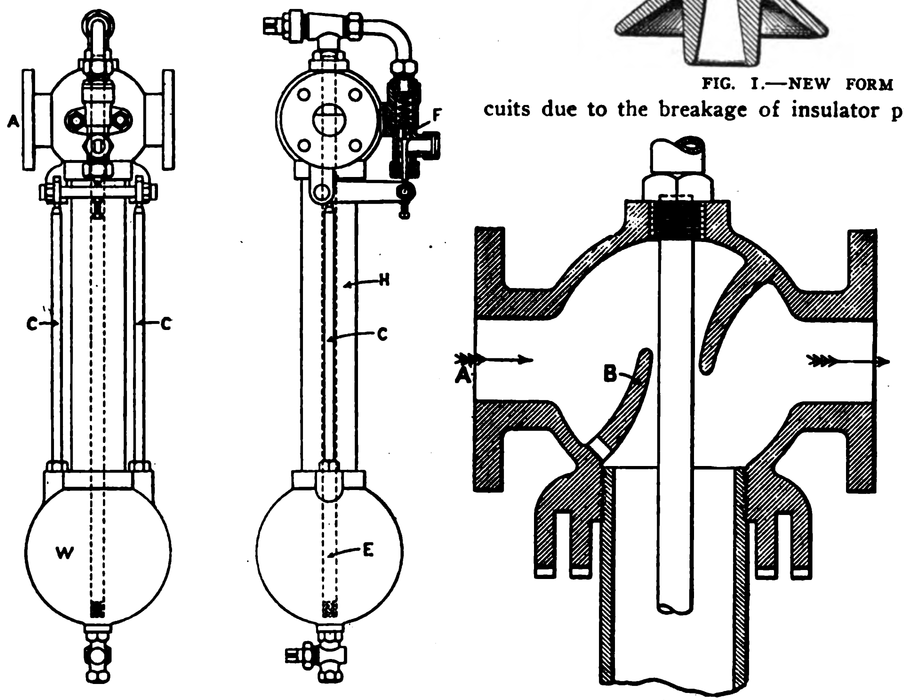

FIG. 5.—WATER SEAL STEAM TRAP AND HEAD OF TRAP.—FIG. 6.

Reduction of Clearance in Oil Engines—In oil engines of the kind in which the vaporizer is connected to the ends of the combustion chamber of the cylinder by means of a narrow neck, the vaporizer and air inlet and exhaust valves have been so arranged that a considerable space or clearance exists in the air inlet and exhaust valve box and between the neck of the vaporizer and the piston when the latter is at the end of its stroke. With a view to avoiding these clearances, the arrangement shown in Figs. 7 and 8 has been designed, and a description of it is given in the London *Mechanical Engineer*. Referring to the illustrations, *A* represents the cylinder of the engine, which is provided with the usual liner *B* and with the piston *C*. *D* is the vaporizer connected to the combustion chamber of the cylinder by the neck *E*, which is formed in the cylinder end *F*, and is curved so that the vaporizer may be located at the side of the cylinder. *G* is the air-inlet valve and *H* is the exhaust valve, these valves being mechanically actuated by levers *I*, one only of which is shown, and which are actuated from the engine by any of the usual methods. The air-inlet valve *G* and the exhaust valve *H* open inwardly relatively with the cylinder, the piston *C* only leaving a very slight clearance at the end of its instroke, as indicated. The valves *G* and *H* follow the piston at the commencement of its outstroke, and to avoid the liability of their coming into contact with the piston *C*, which might happen in the case of quick-running engines, the piston may be made with recesses opposite the valves. The arrangement of the valves and the vaporizer neck in the end of the cylinder enables the amount of clearance heretofore necessary to be very materially reduced, thus increasing the efficiency of the engine, since it is possible to obtain a better compression and the introduction of a larger quantity of compressed air into the vaporizer.

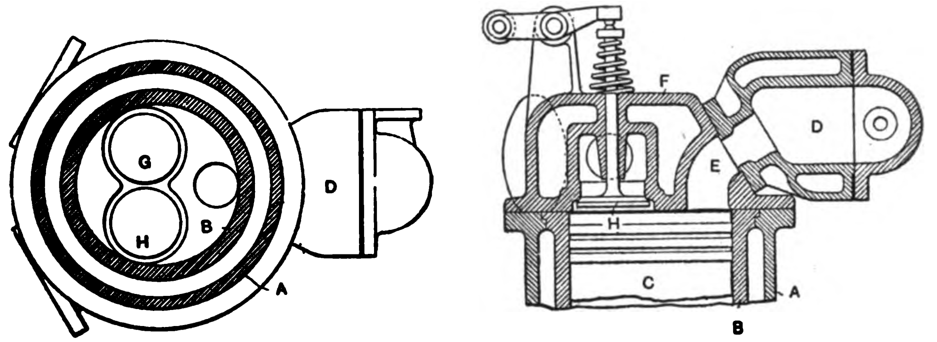

FIG. 7.—SECTIONAL VIEWS OF OIL ENGINE.—FIG. 8.

SOME RECENT ELECTRICAL PATENTS

Insulator.—In order to eliminate the liability of trouble on high potential circuits due to the breakage of insulator pins the form of insulator and pin illustrated by Figs. 1 and 2 herewith has been devised by Fred M. Locke, of Victor, N. Y. The engravings are practically self-explanatory; the insulator has two petticoats, one at each end, and a hole all the way through the centre, so that the pin may be slipped through it and supported at both ends, as shown in Fig. 2. The upper petticoat of the insulator is provided with an eaves

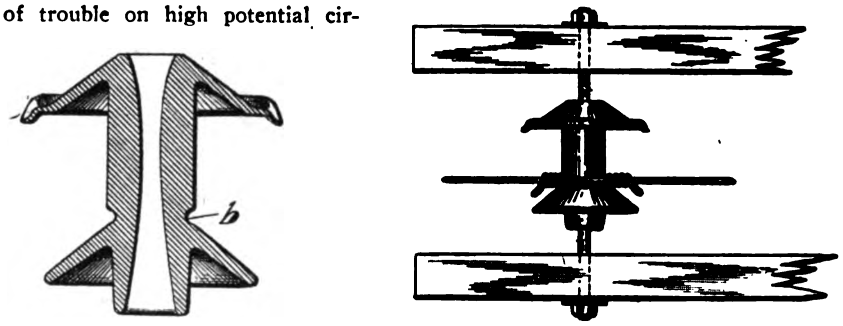

FIG. 1.—NEW FORM OF INSULATOR AND PIN.—FIG. 2.

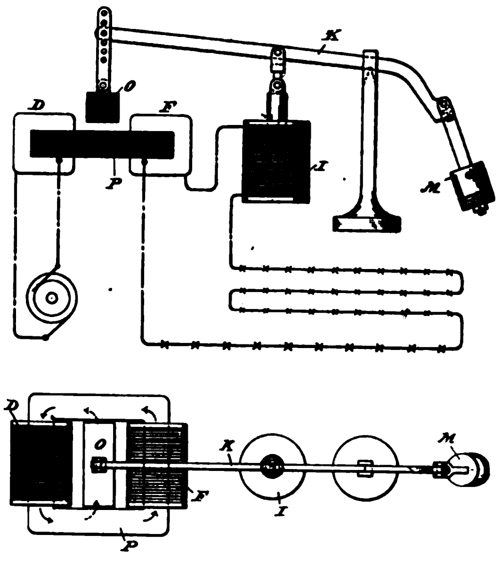

FIG. 3.—HALLBERG'S REGULATOR FOR SERIES CIRCUITS.

trough having drain spouts. The wire groove is located near the top of the lower petticoat, as indicated at b, in Fig. 1.—Patent No. 767,948.

Regulator for Series Alternating Current Circuits.—One might have been pardoned for supposing that every practical form of automatically-variable reactance coil for series alternating-current circuits had been devised some time ago. That this is not true, however, is made apparent by the issuance of a patent to J. H. Hallberg, of New York, for the arrangement shown in Fig. 3. This consists of a core, P, having a closed magnetic circuit, and two coils, D and F; a magnetic bridge or shunt, O, suspended from a lever, K, and counterbalanced by a weight, M, and a solenoid, I, arranged to pull the lever downward and thus introduce the bridge, O, into the stationary core, P. It is evident that the mutual inductance between the coils, D and F, may be varied widely by changing the position of the bridge, P; when the latter is entirely within the opening in the main core, the mutual induction is minimum and the e.m.f. of the coil, F, is, therefore, minimum. The operation is practically obvious from an inspection of the diagram. If lamps are cut out of the work circuit, a momentary increase in the current results, and this causes the solenoid, I, to draw the bridge, O, down into the main core until sufficient magnetic flux is shunted out of the coil, F, to reduce the current to normal. Then the pull of the soleneid, I, is just balanced by the weight, M. A feature peculiar to this form of regulator is that the power factor of the work circuit is kept practically constant by the increase in the self-induction of the solenoid, I, when its core moves downward and thereby reduces the self-induction of the coil, F, by shunting part of the flux out of its leg of the core. Patent No. 722,096.

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Concerning Boiler Tube Cleaners.

To the Editor, American Electrician:

Our attention has been called to an article which has appeared in some of the technical journals in which remarks concerning the effect of using certain types of tube cleaner might possibly be construed as intimating that the cleaners made by us have a deteriorating effect on the tubes. In order to correct any erroneous impression in this direction we wish to state that none of the cleaners made by us delivers a blow to the tube in removing its scale; nor is steam used in driving the cleaners. The work is all done by means of rotating cutter wheels which merely grind the scale away without doing any injury whatever to the tubes.

THE LAGONDA MANUFACTURING CO.
Springfield, Ohio.

CENTRAL STATION ENGINEERS.

II.

Robert E. Richardson.

Robert E. Richardson was born at Concord, Mass., on July 29, 1861. He attended the public schools at Concord until he was 15 years of age, and then prepared for college; entering the Massachusetts Institute of Technology and graduating from that institution as a mechanical engineer with the class of '85. During the fall of 1885 and the following year he taught mathematics and started a manual training course in the military school near Chicago. He then entered the employ of the Western Electric Company in Chicago, remaining with the company four years, during which time he served in various departments and erected and operated many stations. During the latter part of 1889 and in 1890 he was manager of the Milwaukee Electric Light Company. In 1891 he became affiliated with an engineering construction company in Chicago, and in 1892 assisted R. H. Pierce at the Columbian Exposition in Chicago, laying out the arc light system, etc. At the close of the Exposition he became assistant manager of the Ansonia Electric Company, having charge of the lighting and power department. On March 1, 1894, he went into partnership with R. H. Pierce under the firm name of Pierce & Richardson, which company was afterward incorporated under the name of Pierce, Richardson & Neiler, consulting engineers. It was while connected with this company that Mr. Richardson was made manager of the consolidated properties of the Kansas City Electric Light Company. Under his careful guidance these properties were thoroughly rebuilt, and so pleased were the directors with his work that he was asked to remain and devote his entire time to the management of the Kansas City Electric Light Company. The phenomenal growth of this property under his management was recorded in our description of the plant in the June number. The development both in volume of business and improved economy of operation is probably unequalled in the history of electric lighting. Mr. Richardson stands high in engineering, social and sporting circles. He is a member of the American Institute of Electrical Engineers, Kansas City Club, Commercial Club, Driving Club, and one or more golf clubs, and takes an active part in public affairs. He is an athlete and a musician, and has other accomplishments which have endeared him to a host of friends both in Kansas City and among engineers and business men in Chicago and throughout the rest of the country.

ROBERT E. RICHARDSON.

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NOTES.

Interstate Independent Telephone Association will hold its annual convention December 13 to 15 inclusive, in Chicago, with headquarters at the Auditorium. A large attendance is expected by the officials of the association. Special rates have been granted by all the railroads concerned; they may be ascertained from the local agent in any town or city.

American Society of Mechanical Engineers. — The fiftieth meeting of this society will be held in the society's rooms at No. 12 West Thirty-first Street, New York, December 6 to 9 inclusive. There will be a number of unusually interesting papers, among which may be mentioned "Computation of Values of Water Powers," by Charles T. Main; "Condensers for Steam Turbines," by George I. Rockwood; "More Exact Method of Determining the Efficiency of Steam Boilers," by A. Bement, and "The Forcing Capacity of Fire-Tube Boilers," by Francis W. Dean.

Alternating-Current Traction from Gas Power.—The Warren & Jamestown Street Railway Company is engaged in equipping a railway system extending between Warren, Pa., and Jamestown, N. Y., which will involve two departures from the conventional path of railway practice, namely, the use of gas engines to drive the generators in the power-house and of single-phase, alternating-current motors on the cars. The power-house will be located at Stoneham, Pa., two miles from Warren, and the initial equipment is to consist of two Westinghouse gas engines of 500 horse-power capacity each, direct connected to Westinghouse alternators. Natural gas will be used in the engines. Five transformer sub-stations will be distributed along the route and these will, of course, reduce the transmission voltage to a suitable e.m.f. for delivery to the car equipments. The latter will be Lamme single-phase type adapted for operation also on the direct-current lines within the cities at each end of the line.

Electrical Engineering at the Brooklyn Polytechnic Institute.— Dr. Samuel Sheldon, head of the Department of Electrical Engineering at the Polytechnic Institute of Brooklyn, has made a decided innovation in the course in electrical engineering given at that institution. Hereafter the well-beaten paths of academic instruction heretofore followed in this, as well as in other technical institutions, will be somewhat departed from, and while the fundamental training of the student will be entrusted to the corps of regular instructors, the strictly electrotechnical instruction will be given by a staff of engineers, technical authorities in their several specialties, who will act as consulting professors. The instruction given by the latter will be delivered at evening sessions and will form a complete course from a purely technical viewpoint. Engineers and others desiring to complete their technical education will be enrolled, and at the expiration of the course will be eligible for a degree. The consulting professors thus far appointed are as follows: Dr. Louis Duncan, electric traction; Dr. F. A. C. Perrine, electric power transmission; Mr. W. S. Barstow, central station engineering; Mr. Charles F. Scott, commercial engineering; Thomas D. Lockwood, telephony, telegraphy and patent practice.

Calorific Power ot Liquid Fuels.—In a paper recently published in the *Revue Technique*, M. L. Levi makes the following comparison between the calorific values of different fuels used in internal-combustion engines: British thermal units per pound—Methylated alcohol, 10.620; methylated alcohol mixed with 50 per cent gasoline, 14,200; crude American oil, 19,630; refined American oil, 19,880. The mixture of methylated alcohol can, it is stated, be used as easily as ordinary gasoline, but with unmixed gasoline it is necessary to warm up the carbureter a little before starting, as the alcohol does not vaporize readily enough below a temperature of 68° F. As an alternative gasoline may be used at the start, the alcohol being supplied later. No trouble is found with the admission valves in using alcohol, and if at times there is a deposit of soot or tar, this arises generally from the use of a bad carbureter. A little acetic acid results on combustion, but not enough to cause damage. The carbureter should be of a type which will deal out a measured quantity of the liquid at each suction stroke. The exhaust gases are free from the unpleasant smell prevalent in the case of gasoline motors. The principal objection to the use of spirit lies in cost, which, to compete with gasoline, should be about 20 cents per gallon in place of about twice as much, as at present the case in France. In Germany the cost of methylated alcohol is only about 18 cents per gallon, so that the alcohol motor is becoming more and more popular there.

New York Central Electric Locomotive.— The high-speed electric locomotive built by the General Electric Company and the American Locomotive Company for the New York Central & Hudson River Railroad Company was given its first public test on Saturday, November 12. The demonstration took place on a special section of track equipped with a third rail between Schenectady and Hoffman's, N. Y., and was satisfactory in every respect. The general dimensions and data applying to the locomotive are as follows:

No. of driving wheels	8
No. of pony trucks	2
Total weight of locomotive, tons	95
Weight on drivers, tons	69
Rigid wheel base, ft.	13
Total wheel base, ft.	27
Length over buffer platforms, ft.	37
Extreme width, ft.	10
Height to top of cab, ft.	14.3
Diameter of drivers, ins.	44
Diameter of pony truck wheels, ins.	36
Diameter of driving axles, ins.	8.5
Normal rated horse-power of locomotive	2,200
Maximum horse-power	3,000
Normal drawbar pull, lbs.	20,400
Maximum starting drawbar pull, lbs.	32,000
Speed with 500-ton train, m.p.h.	60
Voltage of current supply	600
Normal full load current, amp.	3,050
Maximum full load current, amp.	4,300
No. of motors	4
Type of motor	GE-84-A
Rating of each motor, h.p.	550

The locomotive has four driving axles, on each of which is mounted without intermediate gearing the armature of a motor having a normal rating of 550 horse-power. The total rated capacity of the locomotive is 2200 horse-power, although for short periods a considerably greater power may be developed, thus making the electric locomotive more powerful than the largest steam locomotive in existence. The motor has two poles with flat faces so as to allow a large relative vertical movement between armature and poles as the latter move up and down with the riding of the frame upon the springs. The main frame of the locomotive is of cast steel and serves not only as the mechanical frame of the locomotive, but also as part of the magnetic circuit of the motors. The four motors are arranged in tandem, the end pole-piece being cast as part of the end frames and the double pole-pieces between the armatures being carried by heavy steel transoms bolted to the side frame and forming part of the magnetic circuit as well as cross braces for the truck. The field coils are wound upon metal spools which are bolted upon the pole-pieces. The brush-holders are mounted upon insulated supports attached to the spring saddle over the axle journal, thus maintaining a fixed relation to the commutator. These brush-holders are made adjustable so as to allow for wear of the commutator and journal bearings. The dead weight on the axle is not materially greater than is customary with steam locomotives, and in addition there is no unbalanced weight to produce vibration with attendant injuries to track and roadbed construction. The actual reduction in the expense of maintaining the rails and roadbed, due to the absence of pounding and rolling, will have a great bearing on the upkeep of the permanent way. The superstructure consists of a central cab for the operator, containing master controllers, engineer's valves and switches and valves required for operating the sanding, whistling and bell-ringing devices. This apparatus is furnished in duplicate, one set on each side of the cab, and is arranged so as to be easily manipulated from the operator's seat, while at the same time a practically unobstructed view to front and rear may be obtained from the windows. There is a central corridor extending through the cab, so as to permit access from the locomotive to the cars behind, and the contactors, rheostats and reversers are arranged along the sides of these corridors in boxes of sheet steel which are sheathed on the inside with fire-proof insulating material. The control system permits three running connections, namely, four motors in series, two groups of two in parallel series, and all four motors in parallel. The motor reverser, contactors, rheostats and other controlling appliances are all of the Sprague-General Electric multiple-unit type. The master controller is fitted with a special operating lever and is capable of being moved through an angle of about 75 degrees. A current-limiting device is provided in the master controller, consisting of a friction clutch operated by an electromagnet which is energized by the current passing through one of the motors, the arrangement being such that when the current exceeds a predetermined amount the cylinder cannot be rotated further until the current has fallen sufficiently to permit the relay to drop. Current is collected from the third rail by multiple-contact, spring-actuated, third-rail shoes whose supports are carried on channel irons attached to the journal boxes. There are four of these shoes on each side of the locomotive. The large number of switches and crossings in the yards at the terminals necessitates an overhead construction in places and additional contacts are therefore mounted on top of the locomotive for collecting current when the locomotive is passing through these points. These devices may be raised and lowered by air pressure controlled from the engineer's cab. A magnetic ribbon fuse is placed in circuit with each shoe and overhead-contact device so as to secure protection in case of accidental short-circuit. Current for operating the locomotive is obtained from a rotary converter sub-station at Wyatt's, which is supplied with 11,000-volt, 25-cycle, three-phase current from Schenectady. The voltage of the current supplied to the locomotive is 600. The maximum speeds reached in the trial were 63 miles per hour with an eight-car train and 72 miles per hour with a four-car train. The trial section of track, however, was only four miles long, so that higher speeds could not be attained. Throughout both the starting and running tests, the locomotive showed remarkable smoothness and steadiness in operation. The maximum input recorded at the trial was 4200 amperes at 460 volts, giving an output of 2200 horse-power available at the wheels. With 4200 amperes at a potential of 600 volts the output available at the wheels would be 2870 horse-power. This is secured without in any way exceeding the safe commutation limit of the motors and with a coefficient of traction of only 22.5 per cent of the weight upon the drivers.

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Central Station Records.

The importance of keeping operating records in central stations of even the smallest output is fairly well recognized, and now that plant operation has been reduced to the most rigid business basis no station succeeds in which some sort of operating record is not kept. One of the most vexatious features of record keeping is the determination of the extent to which such records shall be detailed. If the records are too complete, they entail a disproportionate amount of labor in the making and also in the analysis of them, and eventually the work degenerates into perfunctory tabulation and filing, without any analysis beyond comparing the monthly or annual cost of variables with the income for the corresponding period.

It is scarcely necessary to say that every station should be equipped with curve-tracing instruments, as well as indicating instruments, so that the "running" performance of each unit may be inspected day by day; in fact, if it should come to a question of choosing between indicating instruments alone and charting instruments alone, we should strongly prefer to use the latter, excepting the voltmeter, of which both types should invariably be employed: it would be the silliest kind of "economy" to omit either. Charting steam gauges should also be used, one on each boiler or permanently connected battery of boilers and, advisedly, though not indispensably, one at the steam chest of each engine. With these labor-saving appliances and a simple system of weighing coal and measuring water, the hourly performance of a station may be readily reduced to graphic form, curves of the work in each division of the equipment being drawn on a single chart to facilitate direct comparison and analysis. When a continuously recording steam engine indicator shall have been developed, this will still further simplify the work of analyzing the hourly operation of a plant.

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Factory Motors.

It is a well-known fact that the motors in most industrial establishments rarely are operated at full load continuously for considerable periods of time. Leaving out textile mills, daily newspaper press rooms and a few other establishments which may be classified as special, the average electric motor will probably not run at full load during more than 60 per cent of the total working time of each year; this is especially true of machine-tool motors, some of which run at half or a third load for hours at a time. This leads to some deductions which may be useful in the selection of motors for driving industrial machinery—particularly in cases of individual drive or small groups driven by one motor. Obviously, a motor may be used of lower rating than if it had to carry full load continuously 10 hours per day, but it must have a considerably higher percentage of temporary overload capacity than a machine running on a steady load.

As examples of the relation between motor capacity and output in watt-hours per annum the following will be appropriate. In a plant devoted to the building of rather heavy machinery and operated by electric motors, the aggregate capacity of the motors was 590 horsepower. During one month of 26 working days, the total energy delivered to the motors was between 57,000 and 58,000 kilowatt-hours. If the average efficiency of all the motors be taken at 90 per cent, which is rather liberal since the machines were induction motors, the total output figures out between 69,000 and 70,000 horsepower-hours, as compared with the total capacity of 145,730 horsepower-hours (26 days at 9½ hours per day). In another establishment devoted to commercial printing of all classes except the publication of periodicals, the total motor equipment aggregates 38 horsepower and the shop is operated 56 hours per week. The meter bills for three months, during a reasonably busy season, aggregated an amount based on the equivalent of 14,400 horsepower-hours. The motors in this case are direct-current machines and will doubtless average 85 per cent efficiency, the average size being much smaller than in the machine-shop cited. This gives the plant a total capacity, for three months, of 32,540 electrical horse-power-hours. In both of the plants all of the motors were operated during almost all of the time considered, so that the discrepancy between the capacity and the actual output was due almost exclusively to the fact that the motors were operated at less than full load most of the time.

In many establishments, of course, especially where individual motor drive is employed, each motor lies idle a part of each week if not a part of every day, so that even if the motors run continuously at full load while they are active, the monthly load in watt-hours is less than the motor rating of the plant. Consequently, in estimating beforehand the probable cost of operation, the figures, if possible, should always be based on records taken from existing plants of the same general class. In plants where both of the conditions mentioned are likely to exist, the actual cost of operation will, of course, show a greater discrepancy in comparison with the total rating of the motors than in those establishments involving either partial idleness or underload operation alone.

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Connections of Railway Generators.

By usage it has become the rule to connect up railway generators so that the positive terminals are connected to the trolley wire or third rail, as the case may be, and the negative terminals to the track rails. In order to simplify the switchboard construction, the control is single-pole, the negative lead being carried to the track feeder without going to the main switchboard at all. In some cases, the series winding and equalizer connection are at the negative side of the armature; in others, at the positive, or line side. Equalizing on the negative side has the disadvantage that an accidental "grounding" of the armature winding or of the commutator on the core will produce a short-circuit which will not operate the circuit-breaker, the latter being connected, of course, in the positive lead of the machine. On the other hand, equalizing on the positive side of the generator involves carrying the negative lead to the switchboard, because the ammeter and circuit-breaker must be inserted in that lead. It seems plain that the preferable solution, at least in average cases, is to equalize on the negative side and provide a switch pillar near each machine, the pillar to carry the equalizer switch and a single-pole circuit-breaker inserted in the main negative lead. This would eliminate the circuit-breaker from the list of switchboard apparatus and further simplify the construction there; it would, moreover, obviate the liability of having a circuit-breaker "blow" uncomfortably near one's face upon closing a positive switch on a short-circuited or overloaded circuit.

Speaking of closing a switch on a short-circuit recalls an ingenious and simple expedient employed in a certain small power house a number of years ago for the purpose of preventing just such a disagreeable probability. A bank of five 115-volt lamps was connected in series between the line terminal of the circuit-breaker and the generator terminal of the corresponding main switch; all of the lamps were out of sight except one, which was colored deep red and mounted on the board between the main switch and the circuit-breaker so that it was obtrusively visible to anyone trying to close either the switch or the circuit-breaker. With a short-circuit on the feeder, the lamp glowed at practically full candle-power when either the switch or the circuit-breaker was open; with one or more motormen "feeling" for current with their controllers, the lamp glowed dimly; with a perfectly clear line, it remained dark, of course. One of these lamp banks was connected permanently across each switch and circuit-breaker so as to avoid the trouble of switching a single bank from one feeder to another. It is a good investment for any small power station.

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The Consulting Engineer.

Paraphrasing an old adage, "He who is his own consulting engineer has a fool for a client," presuming that "he" is not an engineer of unusually wide experience. The manager or engineer of any except a very large central station who attempts the remodelling or important extension of his plant without consulting some outside engineer who has had wide experience in just that class of work is quite sure to regret it sooner or later. A man concerned with the practical management of one plant cannot possibly keep thoroughly abreast of all developments in the art nor can he keep informed as to the detail experience of other plant managers, although the National Electric Light Association has done a vast deal toward reducing this latter handicap. Consequently, when his plant requires any wholesale "doctoring," it is most wise to go out into the world and get the assistance of someone who is entirely impartial, capable of analyzing conditions with the least expenditure of time and effort, and experienced in the application of remedies to central station ills. Here is where the consulting engineer comes in in central station practice; also the consulting accountant, although the number of cases where the services of an expert accountant are required by a central station is relatively insignificant.

There is no greater fallacy than that of assuming that because a central station plant is relatively small, the owners cannot afford to engage a consulting engineer to supervise any extensions or modifications of importance that the development of business may render advisable. Numerous instances of deplorable wastes of money on plant additions and extensions undertaken without advice from the outside have come without our own observation during the past ten years. The opinion is apparently held by the financial sponsors of electric light and power plants that the man in charge of the technical end of the establishment should be capable of doing all the engineering necessary and of keeping the plant strictly up to date in all of its equipment and operating methods. And the operating engineers themselves appear to feel that it would be reflection on them to call in an outside expert when important changes are necessary. Possibly the respective attitudes of the two classes of men are mutually fostered. However that may be, both are wrong when it comes to extensions of any magnitude in plants not large enough to justify the regular employment of a staff of engineers in contradistinction to a single engineer who is burdened with every technical responsibility connected with the plant and sometimes with its active business management also.

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Engineering English.

While one may very well make one's meaning clear to others by the use of ungrammatical language or uncouth diction, it does not follow that good grammar and clean diction will not convey the meaning much more clearly, leaving out the question of euphony and any consideration of the sensibilities of the reader or hearer. There being no utilitarian excuse for the use of poor diction or the violation of elementary rules of grammar, it is difficult to conceive why educated, or supposedly educated, engineers persist in ascribing personality to pieces of machinery, using both the singular and plural numbers in referring to the same collective noun, describing a deduction first, then the method and finally the premises, or indulging in any other vagaries of expressions or composition. We do not by any means advocate pedantic diction, and we quite agree that some colloquial expressions are better adapted to some purposes than more dignified verbiage would be, but we do wish that engineers—especially young engineers—would take the trouble to analyze their statements and weed out such expressions as "a 10-h.p. motor whose pulley" and "the Blank & Blank Co., which installed in their own factory," and when not too hard pressed for time, revise their writings so as to put statements in logical sequence and eliminate unnecessary verbiage. It would undoubtedly go a considerable distance toward improving their professional reputations. Incidentally, we might say that these remarks are *not* inspired by any manuscript received for publication in this journal, although the casual reader might easily infer that to be the case.

DESIGN AND CONSTRUCTION OF SMALL DYNAMOS AND MOTORS.

BY CECIL P. POOLE.

After having settled the diameter of the polar bore and, consequently, that of the armature core, the number of armature coils must be checked up with regard to the type of winding desired. A simple lap winding, having as many paths through it as there are poles on the field magnet, requires no study; the only consideration is that the number of coils shall be a multiple of the number of field magnet poles. A wave winding is more difficult to deal with. The number of coils for a four-pole machine must be odd; the number for a six-pole machine must be a number *not* divisible by three; it makes no difference whether the number is odd or even. These principles are covered by Rules VI and VII.

Rules.

Rule VI.—The number of coils in a lap-wound armature must be even, and should be a multiple of the number of field magnet poles.

Rule VII.—In a four-pole machine the number of coils in a wave-connected armature may be any odd number.

In a six-pole machine the number of coils in a wave-connected armature may be any number not evenly divisible by 3.

Rule VIII.—The number of wires in a slot must be divisible without a remainder by twice the number of turns per coil.

Rule IX.—In a four-pole machine, with a two-path armature winding, if the number of armature coils = 2 × the number of slots, one coil must be "dead-ended" and left unconnected to the commutator. The remaining coils constitute the "active" coils of the armature.

In a six-pole machine with a two-path armature winding, if the number of armature coils = 3 × the number of slots, one coil must be "dead-ended" and left unconnected. The remainder constitute the "active" coils.

Rule X.—Each armature coil in any machine should span one tooth less than (total teeth ÷ poles), discarding any fraction.

Rule XI.—The terminals of each armature coil must be connected to two commutator segments between which there is the number of segments specified in Table VII.

Rule XII.—The diameter of a commutator barrel must be not less than 0.06 times the number of segments and not more than 6000 ÷ r.p.m.

Rule XIII.—The number of groups of brushes must be two for a wave-connected (two-path) armature winding: For a lap winding, the number of groups of brushes must equal the number of field magnet poles.

Rule XIV.—The total area of all the brush faces must be not less than the armature current per wire ÷ 16 and not more than the armature current per wire ÷ 12.

TABLE VI.—Maximum Safe Number of Turns per Armature Coil.

Amperes per armature wire.			Maximum turns per coil.
Lap Winding.	Two-path Windings. 4 Poles.	Two-path Windings. 6 Poles.	
56.25	42.2	28.125	2
25	18.75	12.5	3
14	10.5	7.	4
9	6.75	4.5	5
6.25	4.7	3.125	6
4.6	3.45	2.3	7
3.5	2.62	1.75	8
2.8	2.1	1.4	9
2.25	1.68	1.12	10
1.86	1.4	0.93	11
1.56	1.17	0.78	12
1.33	1.	0.67	13
1.15	....	....	14
1.	....	....	15
0.88	....	....	16
0.78	....	....	17
0.69	....	....	18
0.62	....	....	19
0.56	....	....	20
0.51	....	....	21
0.46	....	....	22
0.42	....	....	23
0.39	....	....	24
0.36	....	....	25
0.333	....	....	26
0.31	....	....	27

When the actual current per armature wire falls between two of the numbers in the proper column of the table, take the number of turns corresponding to the greater of the two numbers between which the actual current lies.

If the number of slots and wires per slot do not give the proper number of coils, either the wires per slot or the number of slots must be revised to suit. For example, if we are laying out the armature of a four-pole machine which is to have a wave winding, the number of active coils must be odd, and if the total number of coils is equal to the total number of coil slots, then the number of slots must be odd. If, however, the number of coils is twice the number of slots, it makes no difference whether the number of slots is odd or even; but if there are three times as many coils as there are slots, then the number of slots should be odd. In a six-pole machine with a two-path (wave-connected) armature winding, if the number of slots is equal to the number of coils, it must, of course, be a number not evenly divisible by 3; if there are twice as many coils as slots, the number of slots must not be evenly divisible by 1.5, and if there are three times as many coils as slots, the number of slots may be any number whatever, but one of the coils must be left disconnected from the commutator, with the ends cut off close to the coil and taped heavily, as in the case of the four-pole, two-path armature with twice as many coils as slots. (See Rule IX.)

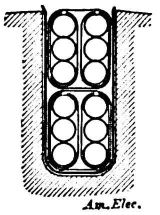

FIG. 4.

The relation between the number of coils and number of slots is determined by the number of turns per coil and the number of wires per slot. The number of wires per slot is necessarily equal to the number of turns per coil × number of half coils per slot. Referring to Fig. 4. there are six wires in the top half and six in the lower half of the slot; the upper six are separated

TABLE VII.—CONNECTION OF ARMATURE COILS TO COMMUTATOR.

For Two-Path Armature Windings.

The numbers in the body of the table are the numbers of commutator bars between the two to which the terminals of any one coil are connected.

NOTE.—The terminals of each coil of a lap-wound armature must be connected to adjacent commutator bars.

No. of coils.	4 poles.	6 poles.	No. of coils.	4 poles.	6 poles.	No. of coils.	4 poles.	6 poles.
21	9	..	81	39	..	141	69	..
22	..	6	82	..	26	142	..	..
23	10	7	83	40	27	143	70	47
25	11	7	85	41	27	145	71	47
26	..	8	86	..	28	146	..	48
27	12	..	87	42	..	147	72	..
28	..	8	88	..	28	148	..	48
29	13	9	89	43	29	149	73	49
31	14	9	91	44	29	151	74	49
32	..	10	92	..	30	152	..	50
33	15	..	93	45	..	153	75	..
34	..	10	94	..	30	154	..	50
35	16	11	95	46	31	155	76	51
37	17	11	97	47	31	157	77	51
38	..	12	98	..	32	158	..	52
39	18	..	99	48	..	159	78	..
40	..	12	100	..	32	160	..	52
41	19	13	101	49	33	161	79	53
43	20	13	103	50	33	163	80	53
44	..	14	104	..	34	164	..	54
45	21	..	105	51	..	165	81	..
46	..	14	106	..	34	166	..	54
47	22	15	107	52	35	167	82	55
49	23	15	109	53	35	169	83	55
50	...	16	110	..	36	170	..	56
51	24	..	111	54	..	171	84	..
52	..	16	112	..	36	172	..	56
53	25	17	113	55	37	173	85	57
55	26	17	115	56	37	175	86	57
56	..	18	116	..	38	176	..	58
57	27	..	117	57	..	177	87	..
58	..	18	118	..	38	178	..	58
59	28	19	119	58	39	179	88	59
61	29	19	121	59	39	181	89	59
62	..	20	122	..	40	182	..	60
63	30	..	123	60	..	183	90	..
64	..	20	124	..	40	184	..	60
65	31	21	125	61	41	185	91	61
67	32	21	127	62	41	187	92	61
68	..	22	128	..	42	188	..	62
69	33	..	129	63	..	189	93	..
70	..	22	130	..	42	190	..	62
71	34	23	131	64	43	191	94	63
73	35	23	133	65	43	193	95	63
74	..	24	134	..	44	194	..	64
75	36	..	135	66	..	195	96	..
76	..	24	136	..	44	196	..	64
77	37	25	137	67	45	197	97	65
79	38	25	139	68	45	199	98	65
80	..	26	140	..	46	200	..	66

into two groups of 3 each, these 3 being the turns in one coil. There are four half coils in this slot, so that the total number of coils on the armature will be 2 × the number of slots. From this it will be evident that

The total number of coils = number of slots × wires per slot ÷ 2 × turns per coil.

TABLE VIII.—Pole-piece Dimensions and Armature Length.

Diam. Polar Bore.	Polar chord and pole-face width parallel to shaft:		Length of armature core between end plates.	
	2 Poles.	4 Poles.	2 Poles.	4 Poles.
3	2 11/16	....	2 15/16	
3 1/16	2 3/4	....	3	
3 1/8	2 3/4	....	3	
3 3/16	2 13/16	....	3 1/16	
3 1/4	2 7/8	....	3 1/8	
3 5/16	2 15/16	....	3 3/16	
3 3/8	3	....	3 1/4	
3 7/16	3 1/16	....	3 5/16	
3 1/2	3 1/8	....	3 3/8	
3 9/16	3 3/16	....	3 7/16	
3 5/8	3 1/4	....	3 1/2	
3 11/16	3 5/16	....	3 9/16	
3 3/4	3 3/8	....	3 5/8	
3 13/16	3 3/8	....	3 11/16	
3 7/8	3 7/16	....	3 3/4	
3 15/16	3 1/2	....	3 13/16	
4	3 9/16	....	3 7/8	
4 1/8	3 11/16	....	4	
4 1/4	3 3/4	....	4 1/16	
4 3/8	3 7/8	....	4 3/16	
4 1/2	4	....	4 5/16	
4 5/8	4 1/8	....	4 7/16	
4 3/4	4 1/4	....	4 9/16	
4 7/8	4 5/16	....	4 5/8	
5	4 7/16	2 5/8	4 3/4	2 7/8
5 1/8	4 9/16	2 11/16	4 7/8	2 15/16
5 1/4	4 11/16	2 3/4	5	3
5 3/8	4 13/16	2 13/16	5 1/8	3 1/16
5 1/2	4 15/16	2 7/8	5 1/4	3 1/8
5 5/8	5	2 15/16	5 3/8	3 3/16
5 3/4	5 1/8	3	5 1/2	3 1/4
5 7/8	5 3/16	3 1/16	5 9/16	3 5/16
6	5 5/16	3 1/8	5 11/16	3 3/8
6 1/8	....	3 3/16	....	3 7/16
6 1/4	....	3 1/4	....	3 1/2
6 3/8	....	3 5/16	....	3 9/16
6 1/2	....	3 3/8	....	3 5/8
6 5/8	....	3 7/16	....	3 11/16
6 3/4	....	3 1/2	....	3 3/4
6 7/8	....	3 9/16	....	3 13/16
7	....	3 5/8	....	3 7/8
7 1/8	....	3 3/4	....	4
7 1/4	....	3 13/16	....	4 1/8
7 3/8	....	3 7/8	....	4 3/16
7 1/2	....	3 15/16	....	4 1/4
7 5/8	....	4	....	4 5/16
7 3/4	....	4 1/16	....	4 3/8
7 7/8	....	4 1/8	....	4 7/16

Example: In the preceding article we found that slots containing 24 No. 13 wires could be used in a 5-h.p. armature, the allowable number of slots being 33. The current per wire being 10 amperes, the number of turns per coil, according to Table VI, could not exceed 4, consequently the number of coils would be $33 \times 24 \div 2 \times 4 = 99$, which is an odd number and therefore practical. But suppose we had tried to work with 20 wires per slot, instead of 24; the calculated number of coils would have been 82.5, which is obviously impossible, even regardless of odd or even numbers. It should be plain, from this, that the number of wires in a slot must be such that it is divisible without a remainder by twice the turns per coil. Hence Rule VIII.

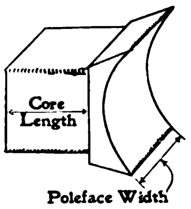

FIG. 5.

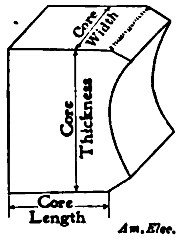

FIG. 6.

Having adjusted the number of slots satisfactorily, and finally settled the armature diameter, the commutator and brushes are the next features to consider. The number of segments in the commutator must equal the number of *active* coils, consequently the number of segments will be determined by Rule VII or VIII. The coils must be connected to the commutator segments in accordance with Rule XI; the construction of the coils and their arrangement on the core will be discussed fully in a future article.

TABLE VIII, continued.—Pole-piece Dimensions and Armature Length.

Diam. Polar. bore.	Polar chord and pole-face width parallel to shaft.		Length of Armature core between end plates.	
	4 Poles.	6 Poles.	4 Poles.	6 Poles.
8	4 3/16	2 7/8	4 1/2	3 1/8
8 1/8	4 1/4	2 15/16	4 9/16	3 3/16
8 1/4	4 5/16	2 15/16	4 5/8	3 3/16
8 3/8	4 3/8	3	4 11/16	3 1/4
8 1/2	4 7/16	3 1/16	4 3/4	3 5/16
8 5/8	4 1/2	3 1/16	4 13/16	3 5/16
8 3/4	4 9/16	3 1/8	4 7/8	3 3/8
8 7/8	4 5/8	3 3/16	4 15/16	3 7/16
9	4 11/16	3 1/4	5	3 1/2
9 1/8	4 3/4	3 1/4	5 1/16	3 1/2
9 1/4	4 13/16	3 5/16	5 1/8	3 9/16
9 3/8	4 7/8	3 3/8	5 3/16	3 5/8
9 1/2	4 15/16	3 3/8	5 1/4	3 11/16
9 5/8	5	3 7/16	5 3/8	3 3/4
9 3/4	5 1/8	3 1/2	5 1/2	3 13/16
9 7/8	5 3/16	3 1/2	5 9/16	3 13/16
10	5 1/4	3 9/16	5 5/8	3 7/8
10 1/8	5 5/16	3 5/8	5 11/16	3 15/16
10 1/4	5 3/8	3 11/16	5 3/4	4
10 3/8	5 7/16	3 11/16	5 13/16	4
10 1/2	5 1/2	3 3/4	5 7/8	4 1/16
10 5/8	5 9/16	3 13/16	5 15/16	4 1/8
10 3/4	5 5/8	3 7/8	6	4 3/16
10 7/8	5 11/16	3 7/8	6 1/16	4 3/16
11	5 3/4	3 15/16	6 1/8	4 1/4
11 1/8	5 13/16	4	6 3/16	4 5/16
11 1/4	5 7/8	4 1/16	6 1/4	4 3/8
11 3/8	5 15/16	4 1/16	6 5/16	4 3/8
11 1/2	6	4 1/8	6 1/2	4 7/16
11 5/8	6 1/16	4 3/16	6 9/16	4 1/2
11 3/4	6 1/8	4 3/16	6 5/8	4 9/16
11 7/8	6 3/16	4 1/4	6 11/16	4 5/8
12	6 1/4	4 5/16	6 3/4	4 11/16
12 1/8	6 5/16	4 3/8	6 13/16	4 3/4
12 1/4	6 3/8	4 3/8	6 7/8	4 3/4
12 3/8	6 7/16	4 7/16	6 15/16	4 13/16
12 1/2	6 1/2	4 1/2	7	4 7/8
12 5/8	6 5/8	4 1/2	7 1/8	4 7/8
12 3/4	6 11/16	4 9/16	7 3/16	4 15/16
12 7/8	6 3/4	4 5/8	7 1/4	5
13	6 13/16	4 11/16	7 5/16	5 1/16
13 1/8	6 7/8	4 11/16	7 3/8	5 1/8
13 1/4	6 15/16	4 3/4	7 7/16	5 3/16
13 3/8	7	4 13/16	7 1/2	5 1/4
13 1/2	7 1/16	4 13/16	7 9/16	5 1/4
13 5/8	7 1/8	4 7/8	7 5/8	5 5/16
13 3/4	7 3/16	4 15/16	7 11/16	5 3/8
13 7/8	7 1/4	5	7 3/4	5 7/16
14	7 5/16	5	7 13/16	5 1/2
14 1/8	7 3/8	5 1/16	7 7/8	5 9/16
14 1/4	7 7/16	5 1/8	7 15/16	5 5/8
14 3/8	7 1/2	5 1/8	8	5 5/8
14 1/2	7 9/16	5 3/16	8 1/16	5 11/16
14 5/8	7 5/8	5 1/4	8 1/8	5 3/4
14 3/4	7 11/16	5 5/16	8 3/16	5 13/16
14 7/8	7 3/4	5 5/16	8 1/4	5 13/16
15	7 13/16	5 3/8	8 5/16	5 7/8
15 1/8	7 7/8	5 7/16	8 3/8	5 15/16
15 1/4	7 15/16	5 7/16	8 7/16	5 15/16
15 3/8	8 1/16	5 1/2	8 9/16	6
15 1/2	8 1/8	5 9/16	8 5/8	6 1/16
15 5/8	8 3/16	5 5/8	8 11/16	6 1/8
15 3/4	8 1/4	5 5/8	8 3/4	6 1/8
15 7/8	8 5/16	5 11/16	8 13/16	6 3/16
16	8 3/8	5 3/4	8 7/8	6 1/4

Note.—Armature cores ¼ inch longer than the pole-face width are to have ¼ inch spacer in the center of the core, to make a ventilating duct ¼ inch wide.

Cores 5/16 inch longer than the pole-face are to have a 5/16-inch spacer in the center; cores 3/8 inch longer, to nave a 3/8-inch spacer, and so on.

The diameter of the commutator barrel—that is, the part on which the brushes press—should be as small as it can be made without entailing mechanical weakness in the segment by making it too thin; on the other hand, the segments should be as thick as they can be made practically so that a brush will not cover too many segments. This leads to large diameters. Rule XII covers this case; the minimum allowable diameter, from the standpoint of mechanical strength of segments, is 0.06 times the number of segments, while the maximum allowable diameter, from considerations of friction between brushes and commutator and the tendency to spark on account of the segments passing a brush at too high a speed, is equal to 6000 divided by the revolutions per minute.

The brushes must be of carbon and mounted in holders which will be described later on. In order to avoid liability to overheating at the contact between the brush face and the commutator, the aggre gate area of all the brush faces must be sufficient to prevent the current per square inch of contact area from exceeding 32 amperes this result will be obtained by observing the first half of Rule XIV; the second part of this rule, limiting the total brush face area to one-twelfth of the current per armature conductor, is for the purpose of avoiding the use of unnecessary material.

The width of the field magnet pole face parallel to the shaft is given in Table VIII, and no departure should be made from these values. The gross dimension of the armature core parallel to the shaft is susceptible of slight variation by varying the ventilating duct, but the net dimension (gross length minus ventilating duct) *must* be equal to the pole-face width parallel to the shaft.

The cross-section of the field magnet core (that part enclosed by the coil) and that of the yoke part of the frame are given in Table IX and these figures must be followed as closely as possible. When round cores are employed, the cross-section cannot always be made to agree exactly with the figures in the table; then the nearest larger size of core must be used—never a smaller one. These figures are based on the use of either cast steel or very soft machinery steel for the magnet cores, and the softest obtainable cast iron for the yoke. If the yoke be made of steel its cross-section need be only ⅗ of the section given in the table for the particular diameter of polar bore. If the magnet cores be made of cast iron, as they might well be in the smallest sizes of machine, the cross-section of each core must be 2⅔ times the value given in the table.

In all four-pole machines, and in two-pole machines of 5 inches polar bore, or larger, it will usually be found advisable to make the poles with extended tips, as indicated roughly in Fig. 5. This will be determined largely, however, by the material used in the cores. If the builder, for any reason, is restricted to the use of cast iron in the magnet cores, then polar extensions will be impossible; in fact, in most cases it will be found that in order to obtain the required cross-sectional area in the core, the dimension transverse to the shaft will be greater than the chord of the pole-face arc. as indicated in Fig. 6; the core dimension parallel to the shaft must never be greater than the pole-face width. Figs. 5 and 6 illustrate the meanings of the terms "width," "thickness" and length," as applied to field magnet cores; also the meaning of "width" as applied to pole faces.

TABLE IX.—Field Magnet Dimensions.

Diam. Polar Bore.	Magnet Core. Cross-section 2 poles.	4 poles.	Coil space along core. 2 poles.	4 poles.	Magnet yoke cross-section. 2 poles.	4 poles.
3	5.8	....	1 1/2	....	7.73	....
3 1/16	6.19	....	1 1/2	....	8.25	....
3 1/8	5.16	....	1 1/2	....	6.87	....
3 3/16	5.49	....	1 1/2	....	7.32	....
3 1/4	5.74	....	1 1/2	....	7.65	....
3 5/16	6.19	....	1 1/2	....	8.25	....
3 3/8	6.55	....	1 1/2	....	8.73	....
3 7/16	6.95	....	1 1/2	....	9.27	....
3 1/2	7.35	....	1 1/2	....	9.8	....
3 9/16	7.76	....	1 1/2	....	10.35	....
3 5/8	8.19	....	1 5/8	....	10.92	....
3 11/16	8.65	....	1 5/8	....	11.53	....
3 3/4	7.59	....	1 5/8	....	10.12	....
3 13/16	7.85	....	1 5/8	....	10.47	....
3 7/8	8.25	....	1 5/8	....	11.	....
3 15/16	8.68	....	1 3/4	....	11.57	....
4	9.12	....	1 3/4	....	12.16	....
4 1/8	10.05	....	1 3/4	....	13.4	....
4 1/4	10.84	....	1 7/8	....	14.45	....
4 3/8	10.17	....	1 7/8	....	13.56	....
4 1/2	11.1	....	2	....	14.8	....
4 5/8	12.1	....	2	....	16.13	....
4 3/4	13.15	....	2	....	17.53	....
4 7/8	14.05	....	2 1/8	....	18.73	....
5	13.31	3.94	2 1/8	1 1/2	17.75	5.26
5 1/8	14.38	4.2	2 1/4	1 1/2	19.17	5.6
5 1/4	15.5	4.54	2 1/4	1 1/2	20.67	6.05
5 3/8	16.7	4.88	2 1/4	1 1/2	20.27	6.51
5 1/2	17.92	5.22	2 3/8	1 1/2	23.9	6.96
5 5/8	16.88	5.57	2 3/8	1 1/2	22.5	7.43
5 3/4	18.1	5.95	2 3/8	1 1/2	24.13	7.93
5 7/8	19.1	5.07	2 3/8	1 1/2	25.47	6.76
6	20.4	5.4	2 1/2	1 1/2	27.2	7.2
6 1/8	....	5.74	....	1 1/2	....	7.65
6 1/4	....	6.1	....	1 1/2	....	8.13
6 3/8	....	6.46	....	1 1/2	....	8.61
6 1/2	....	6.85	....	1 1/2	....	9.13
6 5/8	....	7.24	....	1 1/2	....	9.65
6 3/4	....	7.65	....	1 1/2	....	10.2
6 7/8	....	8.08	....	1 1/2	....	10.77
7	....	8.52	....	1 1/2	....	11.36
7 1/8	....	7.61	....	1 1/2	....	10.15
7 1/4	....	8.02	....	1 5/8	....	10.7
7 3/8	....	8.43	....	1 5/8	....	11.24
7 1/2	....	8.86	....	1 5/8	....	11.82
7 5/8	....	9.3	....	1 5/8	....	12.4
7 3/4	....	9.76	....	1 5/8	....	13.02
7 7/8	....	10.07	....	1 3/4	....	13.43

TABLE IX.—Continued.—Field Magnet Dimensions.

Diam. Polar Bore.	Magnet Core. Cross-section 4 poles.	6 poles.	Coil space along core. 4 poles.	6 poles.	Magnet yoke cross-section. 4 poles.	6 poles.
8	10.73	5.3	1 3/4	1 1/2	14.3	7.07
8 1/8	11.3	5.58	1 3/4	1 1/2	14.98	7.37
8 1/4	10.06	4.61	1 3/4	1 1/2	13.42	6.15
8 3/8	10.52	4.85	1 3/4	1 1/2	14.03	6.47
8 1/2	10.99	5.1	1 7/8	1 1/2	14.65	6.8
8 5/8	11.48	5.25	1 7/8	1 1/2	15.3	7.
8 3/4	11.98	5.51	1 7/8	1 1/2	15.97	7.35
8 7/8	12.49	5.78	1 7/8	1 1/2	16.65	7.71
9	11.39	6.07	1 7/8	1 1/2	15.2	9.09
9 1/8	11.87	6.22	2	1 1/2	15.83	8.29
9 1/4	12.35	6.53	2	1 1/2	16.47	8.71
9 3/8	12.85	6.83	2	1 1/2	17.13	9.11
9 1/2	13.33	5.85	2	1 1/2	17.78	7.8
9 5/8	13.90	6.12	2 1/8	1 1/2	18.53	8.16
9 3/4	14.62	6.39	2 1/8	1 1/2	19.5	8.52
9 7/8	15.17	6.55	2 1/8	1 1/2	20.23	8.73
10	15.75	6.84	2 1/8	1 1/2	21.	9.12
10 1/8	16.34	7.13	2 1/8	1 1/2	21.78	9.51
10 1/4	16.95	7.44	2 1/4	1 1/2	22.6	9.92
10 3/8	17.55	7.62	2 1/4	1 1/2	23.4	10.16
10 1/2	16.17	7.94	2 1/4	1 1/2	21.56	10.6
10 5/8	16.75	8.26	2 1/4	1 1/2	22.33	11.
10 3/4	17.33	8.6	2 1/4	1 1/2	23.1	11.47
10 7/8	17.94	8.8	2 3/8	1 5/8	23.92	11.73
11	18.55	9.15	2 3/8	1 5/8	24.73	12.2
11 1/8	19.19	9.5	2 3/8	1 5/8	25.58	12.67
11 1/4	19.83	9.87	2 3/8	1 5/8	26.44	13.16
11 3/8	20.48	10.1	2 1/2	1 5/8	27.3	13.47
11 1/2	21.16	10.47	2 1/2	1 5/8	28.21	13.96
11 5/8	21.84	10.87	2 1/2	1 5/8	29.12	14.5
11 3/4	22.55	11.1	2 1/2	1 3/4	30.1	14.8
11 7/8	23.27	11.43	2 1/2	1 3/4	31.03	15.24
12	21.6	10.22	2 5/8	1 3/4	28.8	13.63
12 1/8	22.27	10.58	2 5/8	1 3/4	29.7	14.1
12 1/4	22.98	10.8	2 5/8	1 3/4	30.64	14.4
12 3/8	23.66	11.18	2 5/8	1 3/4	31.55	14.9
12 1/2	24.37	11.57	2 5/8	1 3/4	32.5	15.43
12 5/8	25.35	11.8	2 3/4	1 7/8	33.8	15.73
12 3/4	26.08	12.2	2 3/4	1 7/8	34.77	16.27
12 7/8	26.85	12.62	2 3/4	1 7/8	35.8	16.83
13	25.14	13.04	2 3/4	1 7/8	33.52	17.38
13 1/8	25.83	13.29	2 3/4	1 7/8	34.44	17.72
13 1/4	26.56	13.72	2 3/4	1 7/8	35.41	18.3
13 1/8	27.33	14.17	2 3/4	1 7/8	36.44	18.9
13 1/2	28.08	14.44	2 3/4	2	37.44	19.25
13 5/8	28.86	14.9	2 3/4	2	38.48	19.87
13 3/4	29.65	15.36	3	2	39.53	20.48
13 7/8	30.45	15.84	3	2	40.6	21.12
14	28.68	14.11	3	2	38.24	18.81
14 1/8	29.43	14.54	3	2	39.25	19.39
14 1/4	30.2	14.98	3	2	40.27	19.97
14 3/8	30.97	15.25	3 1/8	2 1/8	41.3	20.33
14 1/2	31.79	15.71	3 1/8	2 1/8	42.38	20.95
14 5/8	32.61	16.17	3 1/8	2 1/8	43.48	21.56
14 3/4	33.44	16.64	3 1/8	2 1/8	44.59	22.19
14 7/8	34.29	16.93	3 1/8	2 1/8	45.72	22.57
15	35.16	17.42	3 1/4	2 1/8	46.88	23.23
15 1/8	36.03	17.91	3 1/4	2 1/8	48.04	23.88
15 1/4	36.93	18.21	3 1/4	2 1/4	49.24	24.28
15 3/8	38.12	18.72	3 1/4	2 1/4	50.83	24.96
15 1/2	39.03	19.24	3 1/4	2 1/4	50.04	25.65
15 5/8	40.	19.77	3 3/8	2 1/4	53.33	26.36
15 3/4	40.94	20.1	3 3/8	2 1/4	54.59	26.8
15 7/8	41.9	20.64	3 3/8	2 1/4	55.87	27.52
16	42.9	21.2	3 3/8	2 1/4	57.2	28.27

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The Next Meeting of the National Electric Light Association will be known as the Denver-Colorado Springs Convention; business meetings being held in Denver and social meetings in Colorado Springs.

THE TESTING EQUIPMENT OF A COMMON BATTERY CENTRAL OFFICE.

BY A. DALLAM O'BRIEN.

The position of wire chief in a modern common-battery central office is one that requires not only a considerable amount of technical knowledge, but also no small amount of executive ability. To this position is entrusted the interior and exterior maintenance of the subscribers' lines and stations, as well as the switchboard and central office equipment.

With common-battery systems the question of line insulation is of the utmost importance. An insulation resistance which would be high enough for a magneto installation is oftentimes sufficiently low to cause the operation of the sensitive relays in the common-battery system and to cause false signals to be transmitted to the operators. The principal troubles which occur on substation lines may be usually classified under one of the following heads: Grounds; crosses with other lines or with power circuits; open lines and short-circuits. It is the duty of the wire chief to locate these troubles as quickly as possible and arrange to have them immediately cleared.

For facilitating this work a testing desk is provided in the central office, the testing apparatus being arranged more or less in accordance with the circuits shown in the diagram of Fig. 1. This diagram shows the arrangement of a single test circuit, the number of such circuits depending upon the size of the office and the force employed. The testing lines are usually terminated in a cord and plug at the wire chief's desk, from which point lines terminating at the desk in jacks lead to one of the switchboard positions where they are terminated in a cord and plug. The position on which these lines are placed is connected to the wire chief's talking set by means of a calling circuit, so that at any time the tester may get into communication with the switchboard operator and have any desired subscriber's line connected on any test line leading to the desk.

In addition to these lines, connection is made from the jacks in the wire chief's desk to plugs or clips located at the main distributing frame, so that the outside lines may be tested directly from their point of entrance to the building without the necessity of testing through the switchboard. Referring again to the diagram, key No. 1 has its outside springs connected to the generator which furnishes the ringing current for the exchange. The operation of this key serves to throw the non-grounded side of the ringing generator in connection with the ring conductor of the plug, thus enabling the tester to signal either direct lines or the "A" parties on a two-party line. Key No. 2 is so connected in the circuit that its operation connects the non-grounded side of the ringing generator to the tip strand of the plug and thus serves to ring the other party on a two-party line. Key No. 4 is a reversing key and serves to reverse the connections of all the remaining keys in the test circuit. Key No. 5 is used for throwing a ground on either side of the line for testing purposes when operated in connection with the reversing key. No. 6 in the same way connects the voltmeter to the line to be tested, and No. 7 connects the relay to the line.

Where it is desired to throw ringing current on a line for a considerable length of time, either for the purpose of enabling a lineman to locate a particular conductor or to attempt to raise a subscriber who fails to answer his telephone, key No. 8 is employed. This key, known as the continuous ringing key. is connected to the ringing generator and when used in connection with the reversing key. the current may be thrown at will on either side of the line. Key No. 3 is for listening purposes and in operation bridges the wire chief's talking set across the test cord and enables conversation to be carried on with the operator or with the subscriber whose line is being tested. No. 10 is the retardation coil key and is used by the wire chief when answering calls from the switchboard. The operation of throwing this key bridges the 600-ohm retardation coil across the line, and by operating the supervisory relay in the connecting cord circuit extinguishes the supervisory lamp, thus notifying the operator that the connection has been taken up. Upon the completion of the conversation, the key is returned to its normal position and the supervisory signal in the cord circuit lights, showing the operator that the connection is completed.

The repeating coil key, No. 9, is used for connecting the repeating coil in the talking circuit when the wire chief is connected to a magneto line or toll line. The battery key, No. 11, is utilized in connection with No. 9 for furnishing battery current to the repeating coil. The testing voltmeter is wound with two windings, one to give readings over a 40-volt scale and the other over a two-volt scale. Keys 12 to 16 inclusive are used in connection with the voltmeter, as will be explained later in detail.

The simplest method of testing a line for ground consists in using the relay and sounder; this is accomplished by connecting the test plug to the line and throwing key No. 6 so that the outside springs are brought into contact with the long springs of the key. Current will then flow from the 24-volt battery out over the tip of the testing plug and the line. If a ground be on the tip side of the line, the return circuit will be completed and the relay will operate and in turn operate the sounder, notifying the tester of the existence of the ground. Should the line show clear on this test, the reversing key (No. 4) should be thrown and the test applied to the ring side of the line. While this method is a convenient one for locating the existence of such a trouble, it gives no indication of the location of the ground and can, therefore, be considered only as a preliminary test. The chief use of the relay and sounder is, however, not so much in locating grounds which are outside of the central office, but in enabling the tester to trace out lines in the office itself and in giving an audible signal when a ground is thrown upon a proper line.

For the accurate location of line grounds the voltmeter must be resorted to, and in this connection the two scales and the shunts play an important part. By means of the reversing key the voltmeter may be connected in series with either side of the line and either 40-volt or 2-volt testing current be sent through it. The degree of accuracy which it is desirable to obtain

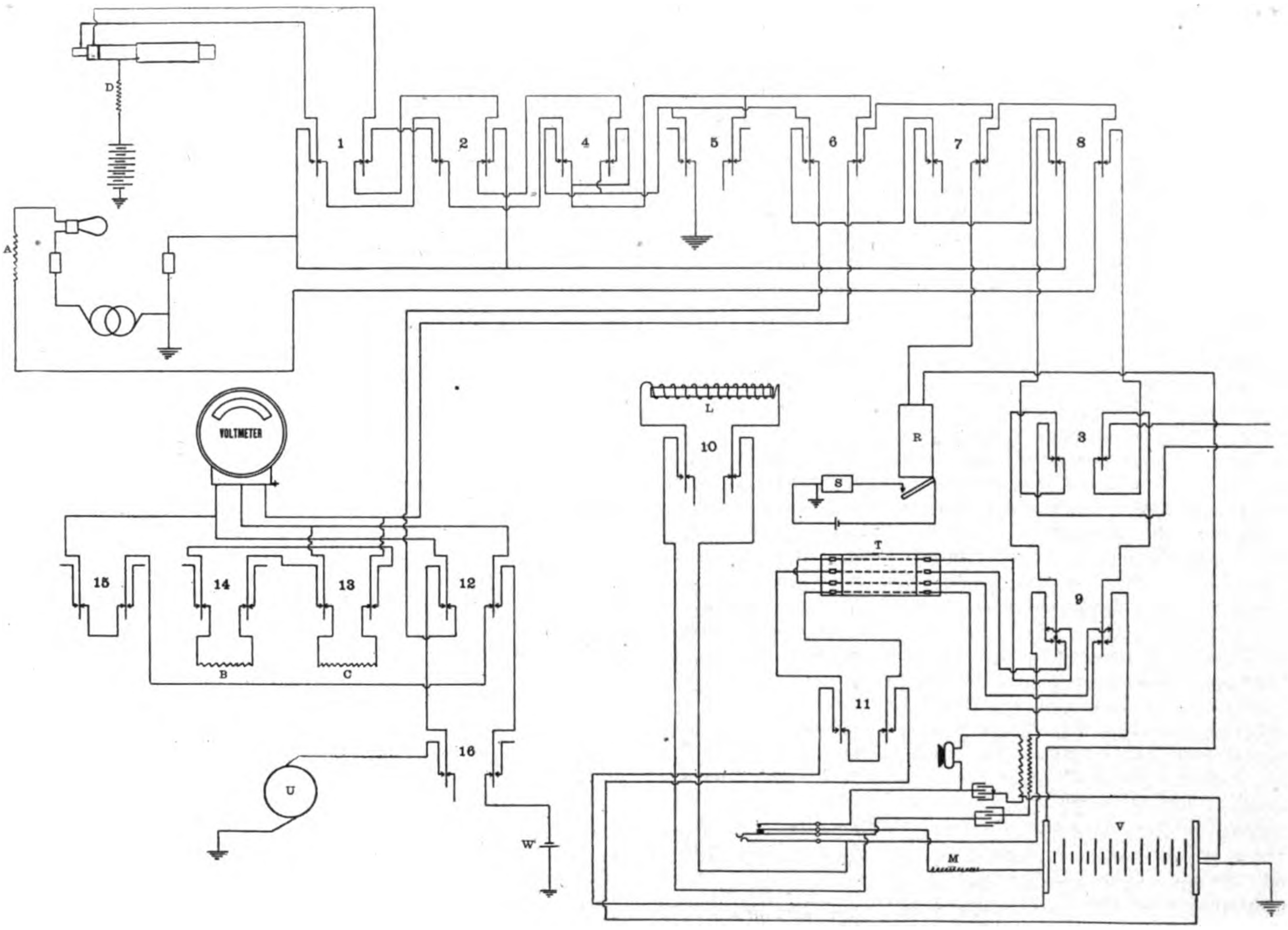

FIG. 1.—DIAGRAM OF CONNECTIONS FOR TELEPHONE TESTING EQUIPMENT.

in locating the trouble determines which of the two testing batteries and voltmeter scales shall be used. If it is desired to use the 40-volt current, it is thrown on the line through the voltmeter by operating keys 16 and 12, this serving to connect the voltmeter and battery in series with the tip side of the line; the further operation of the reversing key connecting the combination with the ring side of the line. If there is a ground, the voltmeter, when connected in this way, will show a reading representing the drop in voltage as the current passes through the instrument. Knowing the resistance of the voltmeter and the voltage of the testing battery, the current which passes through the voltmeter can be calculated from the formula

$$E = IR,$$

where E represents the drop or the reading of the voltmeter, I the current passing through it, and R the resistance of the instrument. The value of the current is, of course, the same at every point in the circuit from the testing battery to the ground on the line, and knowing the current flowing and the voltage applied, the total resistance of the circuit may be readily calculated by means of the formula

$$I = \frac{E}{R}, \quad \text{or} \quad R = \frac{E}{I}.$$

The resistance of the voltmeter being subtracted from this result gives the resistance of the line, including the resistance of the ground, which in ordinary cases may be neglected. From this result the tester, knowing the length and route of the line under test and also the size and resistance of the line conductors, is able to estimate very closely the location of the fault and to give the trouble man sent to clear the ground intelligent data as to where to look for it.

The use of the two-volt battery and scale in testing enables more accurate results to be obtained, as the 2-volt scale may be read with a much greater degree of accuracy than the 40-volt scale. This accuracy may be further increased by the use of the voltmeter shunts, which serve to deflect a portion of the current around the voltmeter. As will be noticed in the diagram, the 40-volt winding of the instrument may be short-circuited or entirely cut out by the operation of key No. 15.

In testing the line for a cross the voltmeter should first be connected to one side of the line, the other side being grounded; the conditions should then be reversed, the reading in both cases being the same. If the cross is of low resistance, as is often the case in troubles of this kind, the distance from the exchange may be readily calculated by means of the formulas given, remembering in the calculation that the line resistance obtained represents twice the length of the conductor from the central office. When a common-battery line in its normal condition is tested by connecting a voltmeter and testing battery in series with it, the voltmeter will show a momentary deflection due to the capacity of the line and the condenser which is bridged across it at the sub-station. In the average exchange, where the subscribers' lines radiating from it are of practically the same length, the deflections thus obtained for the various lines on test will be approximately equal. This feature provides an excellent method for at once ascertaining the existence of an open line, as the absence of the customary condenser reading when the voltmeter is connected to the line indicates an open line; and by operating the reversing key it may be determined whether one or both sides of the line are open. On long lines, even an open line will show some momentary deflection when under test, the deflection being due, of course, to the capacity of the line. The location of the break in cases of this kind is a matter of experience in gauging the voltmeter deflection. In offices having in addition to local substation lines trunk lines which are of considerable length, it is of great importance to include a milliammeter in the wire chief's testing equipment to be used in testing for grounds, crosses and short-circuits on the toll lines, as a much greater degree of accuracy can be obtained in this way than is possible with the use of the voltmeter. Under usual conditions, the tests described are made through the multiple switchboard, but as previously mentioned, provision is made so that the wire chief may, by removing the arresters at the main distributing frame, test directly from that point out on the line, or make his test to include only that portion of the line which is in the exchange itself.

There are numerous instances which arise in practice where breaks occur in the line wires or in cables where the open line is insulated from the ground and other conductors, and in such cases the only possible method of locating the source of trouble is by means of capacity tests. It not infrequently happens in cases of crosses and grounds that the source of trouble itself possesses considerable resistance. When this is the case, the voltmeter method of testing leads to erroneous results regarding the location of the trouble, and in order to correctly determine the point to be looked after it is necessary to make use of a Wheatstone bridge, locating the fault by means of the "Varley loop" test: or if a bridge is not available, the Murray loop test and a resistance box may be employed. Where the trouble is in a cable, one of the two latter methods is necessary in order to locate it satisfactorily, as inspection in this case will avail nothing. In the case of an open wire line, however, it is at least advisable, where the trouble cannot be located by the ordinary test, to patrol the line and attempt to locate it by inspection, and this can usually be satisfactorily accomplished. Where bare copper line wire is used for open wire lines, there is, as a rule, no difficulty in locating these faults. This does not always apply where insulated conductors are used, as numerous cases have arisen in the experience of the writer where the insulation has remained intact while the conductor itself was broken: this class of troubles will usually prove difficult to locate.

There is one class of faults to which a telephone line is liable, that probably occasions more trouble to the testing force than any other difficulty with which they are called upon to deal. These troubles may be classed under the head of "swinging" or "intermittent" faults and may be due to a number of causes. The swaying of the line wires in the wind may often cause temporary crosses; the continual rubbing of an insulated conductor against a tree may result in the destruction of the insulation to a sufficient extent to produce a ground on the line, this being particularly apparent in wet weather and appearing and disappearing with the movement of the wire; improperly soldered joints, or rosin joints as they are usually termed, are also a source of considerable annoyance and are often difficult to locate.

The troubles which occur in the central office itself do not, as a rule, admit of location by test from the wire chief's desk; this is readily accounted for by the small resistance and capacity which the interior lines possess and the consequent necessity of extreme accuracy of the testing methods employed. It is usually not a difficult matter to determine the exact nature of the trouble which exists on the line in an exchange, but the actual location of such faults can only be determined by inspection and trial. As an instance of the peculiar class of troubles which may be met with in the central office, it may be of interest to cite a case which came under the writer's observation some years ago. As is well known, the operators' positions are connected by means of supervisory taps to listening jacks, which are placed in the manager's, monitor's and chief operator's desks. The usual method of making these taps is to run a pair of wires from the secondary side of the operator's talking set to a pair of lugs on the intermediate distributing frame, and from this point to cross-connect these leads to lines leading to the desk jacks. In the case in question, an operator's position was reported as being out of service and a trial developed the fact that the primary side of the operator's set was in perfect condition. No trouble could be located in the secondary portion of the circuit, and yet a test showed that a short-circuit existed. Upon disconnecting the supervisory lead to the intermediate frame, the circuit tested clear, and the trouble was removed. An investigation of the lines from the intermediate frame to the various supervising jacks was then made, and in the jack at one desk was discovered a small piece of lead which had been broken from the point of a pencil. This being removed and the cross-connections re-established, the position tested in good condition and the trouble disappeared. The explanation of this case is, of course, a very simple one. A monitor operator had, while sitting at her desk, broken off the point of her pencil in the jack, and considering it of no consequence, allowed it to remain. The lead of course formed a conductor between the jack springs and short-circuited the secondary of the operator's set. It will be apparent from this instance that there are times when troubles arise in central office apparatus which the most elaborate series of tests will fail to explain. In large central offices the testing equipment is usually arranged in duplicate and installed in a two-position testing desk in order that two men may be able to test at the same time. In addition to the testing equipment, the desk is built to contain a filing case or drawer in which are kept card records of the subscribers' lines entering the exchange. The filing case is usually so arranged that the tester has easy access to the line cards while testing. The line records which are shown upon the card contain all the information regarding the line that it is necessary for the wire chief to know, such as the name and address of the subscriber, the cable conductors and cable by which the line leaves the exchange, the jack and panel on which the line terminates in the office, the point at which the line changes from cable to an open wire line, and the route which the line follows; also information regarding the poles, cross arms and pins on which the line is carried, and the terminal pole or distributing box from which the line is led to the sub-station. With this information and knowing the size of the conductors in the cables and in the open wire line, the wire chief is able to gauge accurately the result of his tests and to tell approximately the pole or manhole near which a specific trouble exists. As previously stated, line troubles which are internal to the office are not amenable to the ordinary methods of testing. A successful inside trouble man depends to a large extent upon his intimate knowledge of the location of the equipment and also upon his knowledge of its weak points. To see some of these men at work, an observer would almost imagine that their rapid location of the source of trouble was due to instinct, and to a certain extent this is undoubtedly true. The inside troubles may be divided into grounds, crosses, opens, short-circuits and relay adjustment, the latter trouble being one that is difficult to remedy with some types of telephone relays, unless placed in the hands of an experienced man who is skilled in that sort of work. A peculiar feature which affects the operation of central offices of this type is the great number of false signals that are conveyed to the operators after lightning storms. These signals are the result of the passage of a portion of the lightning discharge through the carbon arresters in the line to ground, the current carrying with it a sufficient amount of carbon dust to connect the grounded and non-grounded carbon and to throw a permanent ground connection on the line. This results in the operation of the line relay and the consequent illumination of the line signal. In the majority of instances troubles of this kind can be cleared by the operator, who inserts a plug in the line jack and rings over the line.

The method of clearing troubles in the cord circuits and the description of the automatic plugging up line, both of which constitute a part of the wire chief's testing equipment, have been described in recent issues of this paper and for that reason are not given in detail here. The efficiency of any arrangement of testing circuits in practical use is so thoroughly dependent upon the personality of the man at the testing table that it is a difficult matter to say just what testing arrangement is the best. The circuits described herein, however, have been used to a considerable extent and have proven themselves entirely adequate to meet the demand.

There is one feature in connection with the maintenance of a central office which comes directly under the jurisdiction of the wire chief, having a far-reaching effect upon the trouble record; that is, the question of soldering and soldered connections. The telephone current is very small and it is diminished rapidly by resistance in the line, and the effect of a poorly soldered connection is often of a serious nature, so far as the operation of the line is concerned. To insure satisfactory work in this respect, it is absolutely necessary that the soldering irons should be kept clean, that their points should be kept well tinned, and that the contacts to be soldered should be clean and free from grease. If these precautions are observed satisfactory joints will be the result and the troublesome rosin connection will be conspicuous only because of its absence.

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PUMPS IN CENTRAL STATIONS.

BY W. T. EDWARDS.

When estimating the head against which a pump is expected to work, the height should be taken from the surface of the supply to the discharge nozzle; thè location of the pump above the source of supply having nothing whatever to do with the calculations, the vertical distance between the two points mentioned being the head regardless of the bends that the discharge pipe may make. The power required to force water to a given height depends principally on the head just described, and in addition thereto account must be taken of the friction in the pipes, bends and valves. Increasing the head 15 per cent will usually be found sufficient to compensate for the losses due to friction in the pipes, bends, etc.

The power required to force water to a given height depends on the quantity of water required per minute and the height to which it is desired to force it. Suppose, for instance, that it is desired to deliver 1000 gallons of water per minute to a height of 100 feet; what horse-power will be required? The weight of water is 8.33 pounds per gallon at 62° F. Adding 15 per cent to the head to compensate for friction, results in a height of 115 feet; 33,000 pounds raised one foot a minute is the value of a horse-power, so that in this case the horse-power required will be,

$$H.P. = \frac{1000 \times 8.33 \times 1.15}{33{,}000} = 29.$$

Stated as a general rule the horse-power required to raise a given amount of water to a definite height is equal to the weight of the water discharged per minute times the vertical height in feet, divided by 33,000, or, stated somewhat differently, the horse-power required is equal to the area of the water piston in square inches times the water pressure per square inch times the piston speed in ~~feet per~~ minute, divided by 33,000. These rules are applicable to any of the various kinds of pumps; in fact, they can be used to determine the horse-power required to raise water a given height regardless of the agent used.

In most pumps the steam piston is of larger area than the water piston or plunger; the increase in area being from 25 to 50 cent for ordinary pumps, three times for fire pumps, while for hydraulic pressure pumps the ratio depends on the ratio of the steam pressure to the working pressure. This latter ranges from 500 pounds per square inch to 5000 pounds per square inch for special work. In any case, the product of the area of the steam piston in square inches multiplied by the steam pressure in pounds per square inch equals the product of the area of the water piston in square inches multiplied by the water pressure per square inch. This leads to another method of determining the horse-power of a pump which may be written

TABLE I.—Height in Feet to Which Water is to be Raised.

Gallons per minute.	10		20		30		40		50		100		150		200		300		400	
	C.H.P.	15% added.	C.H.P.	15% added.	C.H.P.	15% added.	C.H.P.	15% added.	C.H.P.	15% added.	C.H.P.	15% added.	C.H.P.	15% added.	C.H.P.	15% added.	C.H.P.	15% added.	C.H.P.	15% added.
10	.025	.028	.050	.057	.075	.086	.100	.115	.120	.138	.250	.287	.37	.425	.50	.575	.75	.862	1.00	1.15
20	.050	.057	.100	.115	.150	.172	.200	.230	.250	.287	.500	.575	.75	.872	1.00	1.150	1.50	1.725	2.00	2.30
30	.075	.086	.150	.172	.225	.258	.300	.345	.370	.425	.750	.862	1.12	1.288	1.50	1.725	2.25	2.587	3.00	3.45
40	.100	.115	.200	.230	.300	.345	.400	.460	.500	.575	1.000	1.150	1.50	1.725	2.00	2.300	3.00	3.45	4.00	4.60
50	.125	.143	.250	.287	.375	.431	.500	.575	.620	.713	1.250	1.437	1.87	2.155	2.50	2.875	3.75	4.311	5.00	5.75
100	.250	.287	.500	.575	.750	.862	1.00	1.150	1.250	1.437	2.500	2.874	3.75	4.311	5.00	5.750	7.50	8.625	10.00	11.50
150	.375	.431	.750	.862	1.125	1.293	1.50	1.723	1.870	2.150	3.750	4.311	5.62	6.463	7.50	8.625	11.25	12.937	15.00	17.25
200	.500	.575	1.000	1.150	1.500	1.725	2.00	2.300	2.500	2.875	5.000	5.750	7.50	8.625	10.00	11.500	15.00	17.250	20.00	23.00
300	.750	.862	1.500	1.725	2.250	2.587	3.00	3.450	3.750	4.311	7.500	8.625	11.25	12.937	15.00	17.250	22.50	25.875	30.00	34.50
400	1.000	1.150	2.000	2.300	3.000	3.450	4.00	4.600	5.000	5.750	10.000	11.500	15.00	17.250	20.00	23.00	30.00	34.50	40.00	46.00

thus: *H.P. = steam pressure per square inch × piston speed in feet per minute, divided by* 33,000.

There is a loss of power aside from the loss due to friction of moving parts in pumps, by which the power developed in the steam end cannot be reconciled to the quantity of water delivered under a certain head. There is a percentage of loss in the actual delivery compared to the calculated delivery as determined by the displacement and piston speed. These losses are due to faulty design of valves which are of such size or shape as to prevent the free passage of water into the pump barrel so as to fill it completely before the return stroke of the piston or plunger. High speed is also conducive to large loss, as the valves do not have time to become seated before the return stroke, thus allowing water to remain in, and return back into the cylinder. This loss is called slippage or pump slip, and is sometimes considered to be as large as 15 per cent of the calculated discharge; though in well-designed pumps it should not be more than 5 per cent.

TABLE II.—Pressure per Square Inch into Feet Head of Water.

Pounds per sq. in.	Feet head.	Pounds per sq. in.	Feet head.	Pounds per sq. in.	Feet head.
1	2.31	40	92.36	170	392.52
2	4.62	50	115.45	180	415.61
3	6.93	60	138.54	190	438.90
4	9.24	70	161.63	200	461.78
5	11.54	80	184.72	225	519.51
6	13.85	90	207.81	250	577.24
7	16.16	100	230.90	275	643.03
8	18.47	110	253.98	300	692.69
9	20.78	120	277.07	325	750.41
10	23.09	125	288.62	350	808.13
15	34.63	130	300.16	375	865.89
20	46.18	140	323.25	400	922.58
25	57.72	150	346.34	500	1154.48
30	69.27	160	369.43	1000	2308.

Table I gives the theoretical horse-power also the horse-power allowing 15 per cent for friction, etc., that will be required to raise different quantities of water to different heights. Table II gives the pressure in pounds per square inch for various heads or heights of columns of water. Table III gives the equivalent pressure per square inch for various heads of water in feet. Table IV shows the quantity of water in gallons actually discharged per minute by pump cylinders of diameters from 2 inches to 20 inches and a piston speed of 100 feet per minute.

In calculating the size of pumps required for boiler feeding, a simple rule easily remembered is that one gallon per minute of theoretical discharge will supply water for 10 boiler horse-power, and a circulating-pump will be required to supply from 30 to 50 gallons for each gallon supplied by the boiler feed-pump.

The piping system to a pump should receive very careful consideration in order that the pump should work with the best efficiency. With this end in view, care should be taken to have all joints absolutely air tight; all bends should be of large radius, and their number as small as possible; the run should be as short as practicable and no needless valves should be used. This last, aside from the benefits to the working of the pumps, should be considered from an economical standpoint, as it will have a material bearing on the cost of installation. The greatest natural pressure that can be employed to get water into the pump is 14.7 pounds per square inch. This pressure cannot under any circumstances be increased so that it is extremely desirable that the friction in the suction pipe be reduced to the lowest possible amount so that pumps running at high speed will be able to get as much water as can be handled by the pistons at the given speed. This is accomplished by having the suction pipe of a size that will keep the velocity of water at not over 200 feet per minute. This speed is about that at which pumps give the best service and is obtained where the suction pipe is not more than 25 feet in length; when this length is increased the speed should be decreased, depending on the length of the suction pipe. The suction pipe should be of uniform diameter from end to end; enlargements should be avoided as they interfere with that uniform rate of flow so essential to the proper filling of a pump. If the suction pipe, from any cause, has to be made larger than the inlet to the pump, a conical piece of pipe should be used and attached directly to the suction flange of the pump or as close to it as possible. It should have a continuous and uniform rise from the water level of the supply to the pump. Any irregularity in laying which would tend to form air pockets in the pipe must be avoided if good results are to be expected. Should the supply be taken from a pond it is well, if possible, to have the horizontal run of the pipe laid below the surface of the supply, the vertical lift coming directly at the pump; by this arrangement most of the suction pipe is always under water and liability to air leakage is eliminated. Where the suction pipe is placed under ground nothing but cast iron pipe, flanged together, should be used. In laying the suction pipe, as well as in making up all lines of pipe, steam or water, care should be taken so that no foreign matter gets into the pipes, such as sand, iron chips, scale, bolts, nuts, etc.; such materials cause a great deal of trouble.

TABLE III.—Feet Head of Water into Pressure, per Square Inch.

Pounds per sp. in.	Feet head.	Pounds per sp. in.	head. Feet	Pounds per sp. in.	head. Feet
1	.43	60	25.99	200	86.62
2	.87	70	30.32	225	97.45
3	1.30	80	34.65	250	108.27
4	1.73	90	38.98	275	119.10
5	2.17	100	43.31	300	129.93
6	2.60	110	47.64	325	140.75
7	3.03	120	51.97	350	151.58
8	3.40	130	56.30	400	173.24
9	3.90	140	60.63	500	216.55
10	4.33	150	64.96	600	259.85
20	8.66	160	69.29	700	303.16
30	12.99	170	73.63	800	346.47
40	17.32	180	77.96	900	389.78
50	21.65	190	82.29	1000	433.09

The suction pipe should be absolutely tight; about this there should be no question, as upon the tightness of the pipe depends the efficiency of working if not successful operation of the pump. Should the pipe leak it must be tested, joint by joint, until the leaks are discovered. To do this the pipe must be laid bare, even though it has been buried in a trench. A good, practical way to test a pump for leaks is to blank off the suction pipe and the discharge end with blank flanges, then fill pump and suction pipe with water. Insert in some convenient place on the suction pipe a pressure gauge, and with a small hand force pump create a pressure of 40 or 50 pounds per square inch; then shut off the force pump connection with the pipe and pump and watch the pointer on the pressure gauge. If the pressure falls there is a leak, and if the pipe be accessible throughout its length the leak can readily be found when the pump is in operation by the hissing sound of the air rushing into the pipe. The exact location of the hole may be found by holding a lighted match or candle to the place, the movement of the inrushing air deflecting the flame toward the hole in the pipe.

A strainer should be placed in the suction pipe to keep out foreign matter, such as fish, twigs, leaves, etc. This should preferably be placed at some accessible point. When placed at the submerged end of the suction pipe it cannot be conveniently reached. There is, however, a make of screen, now on the market, that can be raised from its position at the bottom of a suction pipe, cleaned and returned.

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SOME HINTS ON CONDUIT WORK.

BY T. F. M'MACKIN.

The installation of iron pipe conduit in non-fireproof factories or buildings is quite common, and the number of buildings to be thus equipped is ever increasing. In the present article, however, this class of building will not be considered; instead, some points in the installation of conduit in fire-proof structures will be taken up and illustrated.

Practice has proved that in fire-proof structures, iron pipe conduit can be used where it is impossible to run cleats, porcelain or even bare wires. By way of illustration the writer has in mind a newspaper office in this city. The building had been used a sub-station for a street railway company, and when vacated by the railway company was remodelled into an office building. Naturally the building was of fire-proof construction, with terra-cotta floors and wrought iron frame work. To make a finished ceiling wire lath was installed and covered with plaster.

TABLE IV.—Discharge of Pumps with a Piston Speed of 100 Feet per Minute.

Diameter of cyl's in inches.	Theoretical discharge in gals.	Discharge allowing 15% for slippage.
2	16.32	13.87
4	65.28	55.48
6	146.90	124.86
8	261.10	222.00
10	408.00	346.80
12	587.50	499.37
14	799.70	679.74
16	1044.00	887.40
18	1322.00	1123.70
20	1632.00	1386.20

For the lighting system, main feeders were run from the main switchbox in the cellar to a switchbox located on the east wall of the ground floor of the building, entering the same from the bottom. The different lighting circuits were run from this distributing board in ½ in. iron pipe conduit, six to twelve lights being carried on a single circuit. The points requiring lights were in the center of arches so that girders or I beams were not available.

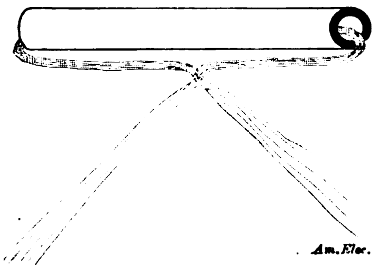


FIG. 1.

A primitive method of securing conduit to a wire lath ceiling is illustrated in Fig. I. A small ¼-in. nipple 3 ins. long has several fine copper wires run through its bore and these are twisted together at the center. A small hole is cut in the ceiling and the nipple is driven in upright past the lath. A sharp pull downward serves to adjust the device and two men hold the conduit while a third draws the loose ends around the pipe and fastens them at the bottom by twisting. To obviate this makeshift and at the same time provide a more permanent device, a little adjustable bolt, known as a toggle bolt and shown by Fig. 2 herewith, was introduced. This is made in two parts, a rod or bolt and a plate attached thereto. The construction is clearly shown in the engraving, but several other forms of toggle operating on the same principle are on the market. The plate is held in a vertical position when being installed in the ceiling, and as soon as the end clears the upper side of the lath or fireproof brick as the case may be, the plate, owing to one end being heavier than the other, assumes a horizontal position. These toggles are generally used to fasten the conduit boxes in place. The boxes support the conduit pipes which run from outlet box to outlet box, entering same a distance of about ½ in.

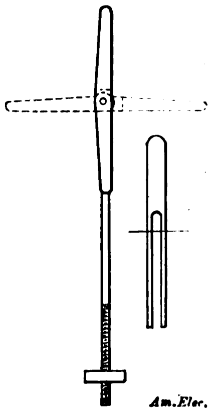


FIG. 2.

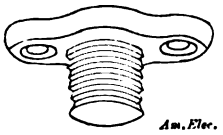


FIG. 6.

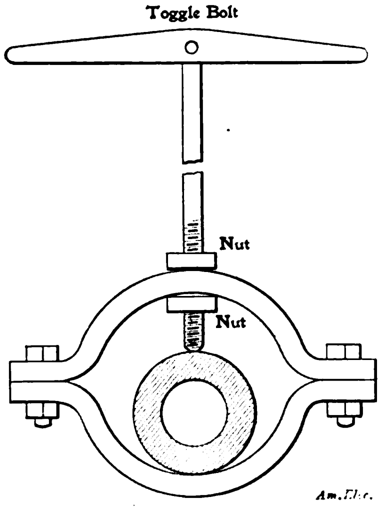


FIG. 3.

When long runs are required and the conduits run 6 or 7 ins. below the ceiling, special hangers must be attached to the lower end of the toggle bolt. To show how easily this may be accomplished reference should be made to Fig. 3. Here two ordinary ½-in. galvanized iron pipe straps are employed, a small hole being either drilled or punched in the center to admit the end of the toggle bolt. Short flat head bolts and nuts ⅛ in. in diameter hold the two straps together, and lock nuts are provided to hold the combination in position as well as the conduit which rests in the lower part of the hanger. If it is desired to have the job present a neat appearance, the exposed part of the toggle may be encased in a ¼-in. nipple which should be long enough to make a tight fit from the upper strap to the ceiling.

The device shown in Fig. 3 serves very well on a single pipe, but where four or five conduit lines are to be accommodated some other means must be provided. Fig. 4 shows a simple hanger for this purpose. In the case under discussion the conduits were two feet lower than the ceiling so that extra long toggle bolts had to be used. A wrought iron bar having a ¼-in. hole at each end is slipped over the rods and held in place by two small nuts. In this manner both of the toggle bolts are connected together and thus support the conduits. In passing under wrought iron beams, a thin piece of band iron with hooked ends is fastened to the girder or beam, the band iron running in the same direction as the conduit or circuit. The conduit is fastened to this band iron by means of a short piece of No. 12 galvanized iron wire. The long rods mentioned above have a 1¼-in. piece of gas pipe covering the exposed parts.

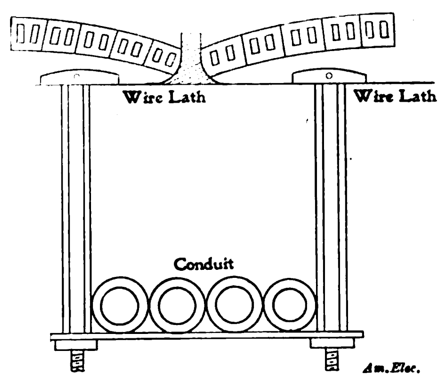


FIG. 4.

Fig. 5 shows the cluster light attachment. The conduit boxes used are round and flat on top and bottom. Five holes ⅝-in. in diameter are provided in the back and four holes equally distant from each other are provided in the side. These holes are covered with blind iron washers held in place by a preservative or insulating compound, and whenever an opening is desired one of these washers is knocked away or forced out with a hammer. The wires are bared and two extra lengths of wire spliced thereto in accordance with the rules of the National Board of Fire Underwriters. A special cover and short piece of pipe are provided. A fixture support, Fig. 6, is made fast to the back of the box and an insulated joint is made on the threaded portion of the fixture lug, one wire being passed through a small opening or slit in either side of the joint. The short length of pipe is fastened to the lower end of the fixture support and a combination socket is provided accommodating from 3 to 5 lamps with an opalescent shade. Short saddle bends were made where one pipe had to pass over another. Toggle bolts were used to fasten the switchbox to the side of the wall; one in each corner and one in the center of the box. The installation was neat in appearance and at the same time not very expensive.

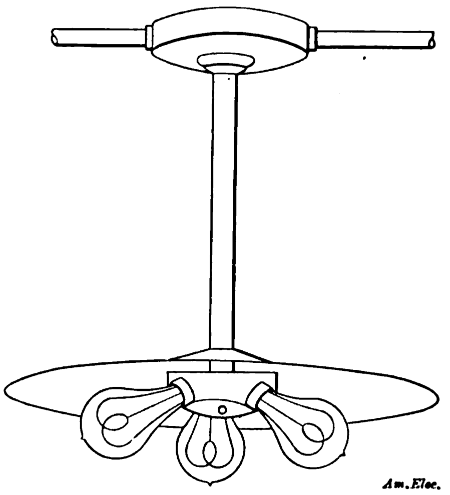


FIG. 5.

Greenfield tubing is used on many jobs where economy is practiced. This is a flexible tube composed of iron or steel wound or twisted about a soft metallic inner core. It is much easier to run than conduit pipe; but care must be exercised in fastening the tubing to the boxes. The necessary length of tubing is cut off with a hack saw, the tubing running from outlet box to outlet box. To fasten it securely to the box a special coupling (Fig. 7) or clamped fitting is provided. One end fits over the tubing and is clamped thereto with a screw. The other end has a female thread accommodating a chased nipple. These fittings are of brass and used only at outlet boxes. This idea is not generally known; but the

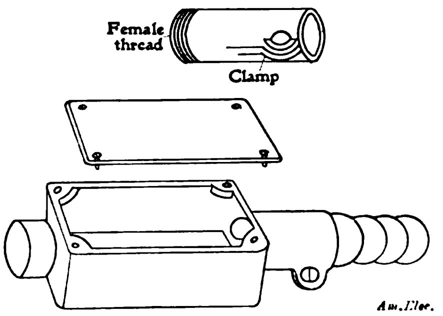


FIG. 7.

customary method of attaching an iron collar to the end of the tubing after it enters the box is also followed. Iron pipe conduit work stands in a class separate from all other branches of work in the electrical trade. Skill and taste are required in installing it and many electricians who cannot work on the line show great facility in this class of work and vice versa.

Lessons in Practical Electricity

THE ROTATING MAGNETIC FIELD.

Like the currents which produce them, magnetic fluxes due to alternating currents have phase relations. If two coils of wire be mounted on a single core and two currents, differing in phase, be passed through the coils, the magnetic flux set up in the core will be the resultant of the two fluxes that would be set up by the two coils separately. Thus, if the currents were equal in strength but differed in phase by a quarter of a cycle (commonly termed 90°), they could be represented graphically by two vectors of equal length 90° apart, as shown in Fig. 1. The fluxes that would be set up by the coils separately could also be represented by the same vectors, since the magnetic lines of force rise and fall in the same way as the current that produces them. The resultant of the two fluxes, therefore, may be plotted graphically by combining two vectors each representing one of them, the two being given the phase relation corresponding to that of the magnetizing currents; this combining of vectors is illustrated in Fig. 2 and was explained in the preceding lesson.

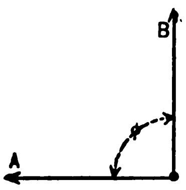


FIG. 1.

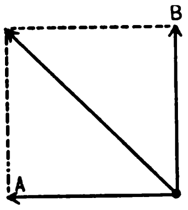


FIG. 2.

For a practical example, suppose two coils to be wound on an armature core with their axes at right angles, as indicated in Fig. 3; a current passed through either coil will produce a magnetic flux in the core parallel to the wires of the other coil; when both coils are energized by the same current, the resultant flux is in the direction exactly half way between that of each of the individual fluxes, as indicated in the diagram. (For the sake of simplicity the dotted lines representing the magnetic flux are not carried all the way across the core, but it will, of course, be understood that the flux passes through diametrically.) The strength of this resultant flux may be measured by the parallelogram method, just as the resultant of any two forces is measureable, if the strength of each is known. Thus, in Fig. 3, if the flux set up by each coil separately is 100,000 lines, the resultant flux would be 141,421 lines, assuming the permeability of the core to be constant, because the ratio of the diagonal of a square to one of its sides is 141,421, and this is the relation between the resultant of two equal forces at right angles and either one of the forces alone.

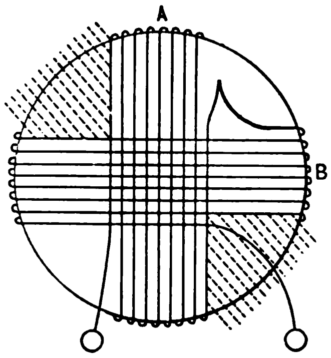


FIG. 3.—TWO COILS AT RIGHT ANGLES, AND RESULTANT FLUX.

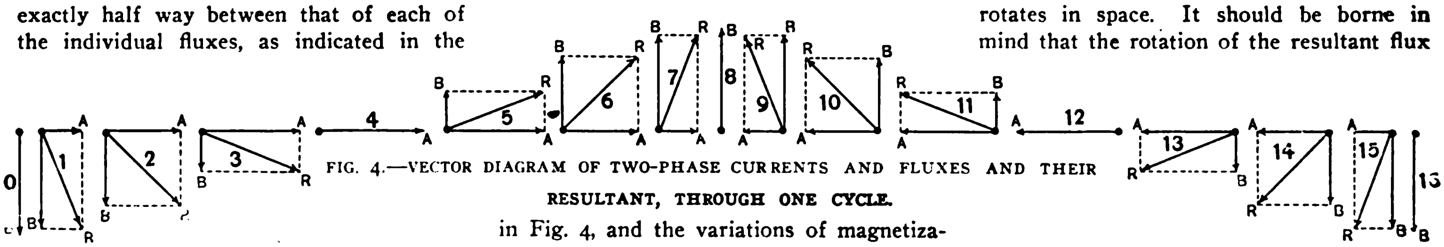


FIG. 4.—VECTOR DIAGRAM OF TWO-PHASE CURRENTS AND FLUXES AND THEIR RESULTANT, THROUGH ONE CYCLE.

Now, if the two windings be separated and energized individually by two currents differing in phase by a quarter of a cycle, a combination effect will be produced. At the instant when the two currents are of equal strength, the resultant flux due to the two coils will be in the intermediate direction shown in Fig. 3; at all other instants the axis of the flux will be somewhere else. This is indicated graphically by Fig. 4, which is a vector diagram of a rotating field produced by two currents a quarter of a cycle apart in phase and passing through two coils mounted with their axes differing by a quarter of a circle (usually termed "differing in mechanical phase" by 90°). When the current in coil *A* is 0, the flux will be produced by coil *B* alone, and its direction will be parallel with the wires of coil *A*, as indicated by the vector *B* in Fig. 4; it is assumed that the direction of the current in coil *B* at this instant is such as to cause the flux to pass from the top to the bottom of the core, as the latter is drawn in Fig. 3. The subsequent variations of the flux-producing ability of coil *B* are indicated by the vertical vectors marked *B* in Fig. 4, and the variations of magnetization due to coil *A* are indicated by the horizontal vectors marked *A*. The lengths of these vectors may be verified by reference to Fig. 5, which shows the two sine waves of magnetism produced by the alternating currents in the two coils, the magnetizing strength of each at each successive 16th of a cycle being indicated by the vertical lines drawn from the 0 line to the curve. It must be remembered that the vertical lines in the upper half of Fig. 5 are changed to horizontal vectors in Fig. 4 because the direction of the magnetizing force set up by coil *A* is horizontal.

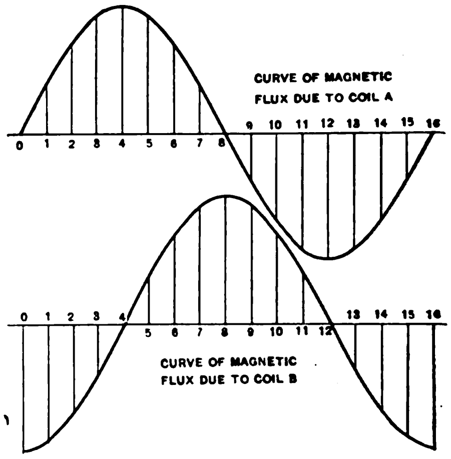


FIG. 5.—TWO-PHASE CURVES.

Returning to Fig. 4, if we assume that the flux set up by either coil alone would be 100,000 lines, and that the permeability of the core is constant so that the flux varies exactly with the strength of the current in the coil, the lines of force that would be produced at each successive 16th of a cycle by coils *A* and *B*, and the resultants of the two, would be as follows:

Increments of cycle.	Coil A.	Coil B.	Resultant flux, 100,000 lines: Angle and direction.
Starting	0	100 000	Vertical, downward.
1st 16th	38 268	92 388	67½° downward, right.
2d 16th	70 711	70 711	45° downward, right.
3d 16th	92 388	38 268	22½° downward, right.
4th 16th	100 000	0	Horizontal.
5th 16th	92 388	38 268	22½° upward, right.
6th 16th	70 711	70 711	45° upward, right.
7th 16th	38 268	92 388	67½° upward, right.
8th 16th	0	100 000	Vertical.
9th 16th	38 268	92 388	67½° upward, left.
10th 16th	70 711	70 711	45° upward, left.
11th 16th	92 388	38 268	22½° upward, left.
12th 16th	100 000	0	Horizontal.
13th 16th	92 388	38 268	22½° downward, left.
14th 16th	70 711	70 711	45° downward, left.
15th 16th	38 268	92 388	67½° downward, left.
End of cycle	0	100 000	Vertical, downward.

Measuring the lengths of the vectors in Fig. 4 would verify these figures if the measurements could be made to the requisite degree of accuracy. It will be observed that although the two fluxes vary from zero to maximum twice in a cycle, corresponding to the variation of the exciting current in each coil, the resultant flux is *not alternating at all*, but remains with a fixed value of 100,000 lines; its axis merely rotates in space. It should be borne in mind that the rotation of the resultant flux is gradual; it does not jump suddenly from one position to the next, as a too literal interpretation of the diagrams might lead a beginner to suppose. The cycle has been divided into sixteen steps merely for convenience and to shorten the discussion of the variation in strength.

The case of the magnetic flux set up by three-phase currents is very similar to the one just explained, but its analysis is not quite so simple. Fig. 6 shows three curves, representing the rise and fall of three alternating currents equal in strength but differing in phase by one-third of a cycle (commonly termed 120°); the individual fluxes set up by the three currents vary exactly like the currents themselves, as already explained, so that the curves may be considered as representing the values of the fluxes. If the three coils producing these fluxes be mounted on a core of constant permeability, as indicated in Fig. 7, a resultant rotating flux of constant strength will be produced, as in the case of the two-phase coils. Having discussed the two-phase arrangements fully, it will not be necessary to follow the three-phase cycle all the way through; one-quarter of a cycle will be sufficient.

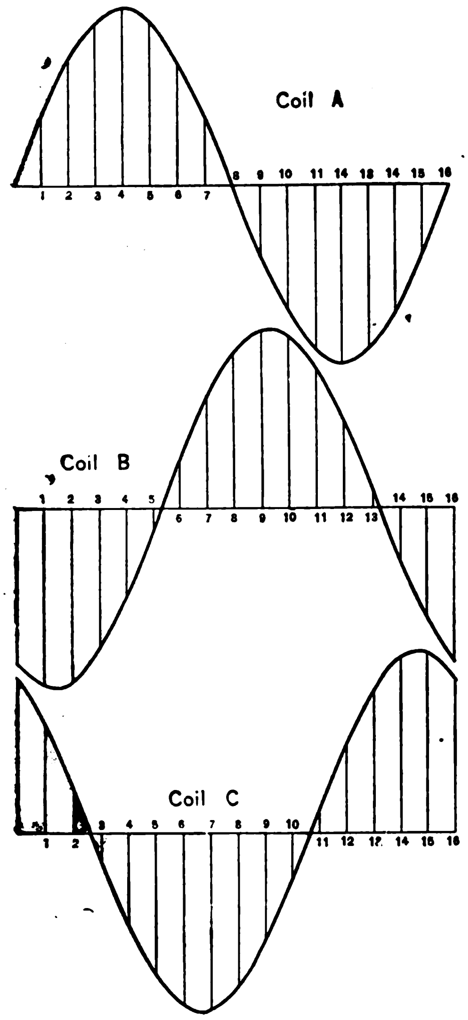


FIG. 6.—THREE-PHASE CURVES.

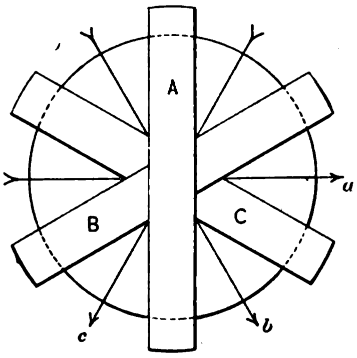


FIG. 7.

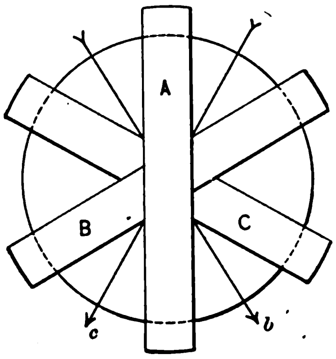


FIG. 8.

We will assume that at the beginning of the cycle under consideration the current in coil *A* is 0; that the current in coil *B* would produce a flux in the direction of the arrow *b* if the other coils were absent, and that the coil *C* would produce a flux in the direction of the arrow *c*, if alone. Under these assumed conditions, which actually occur at the beginning of every third cycle, the resultant flux in the core at the beginning of our cycle will be due to the two coils *B* and *C*; the direction will be downward across the core, parallel to the wires of coil *A*, and the strength of the resultant flux will be the sum of the two individual fluxes multiplied by the cosine of the angle between each individual flux and the resultant. The angle here is 30° and the cosine of this is 0.866; consequently, the resultant flux at the moment of starting the cycle will be 0.866 times the sum of the two fluxes. At this instant each of the fluxes has only 0.866 of its maximum value (see Fig. 6), so that the resultant is 1.732 × 0.866 × maximum individual flux, or 150,000 lines, if each coil alone is capable of producing 100,000 lines of force at the maximum. At the end of the first 16th of the cycle, the coil *A* is producing a flux which, alone, would be 38,268 lines and have the direction of the arrow *a*. The resultant flux is now the combination of the three fluxes, all different in strength. The combination of these by vectors is illustrated by Fig. 9, second position. This diagram gives the strengths and directions of all three fluxes at each 16th of a cycle, through one-quarter of it. The variations through each succeeding quarter of a cycle are exactly the same, excepting the direction of the axis of the resultant flux. From this it will be evident that three currents of equal strength differing in phase by one-third of a cycle and passing through three coils mounted as shown will produce a resultant flux which has a constant strength but rotates in space. It will also be plain that the resultant magnetizing force of three coils and currents of the kinds mentioned is 1½ times that of two coils and currents of the kinds first described, the individual currents and number of turns per coil being equal.

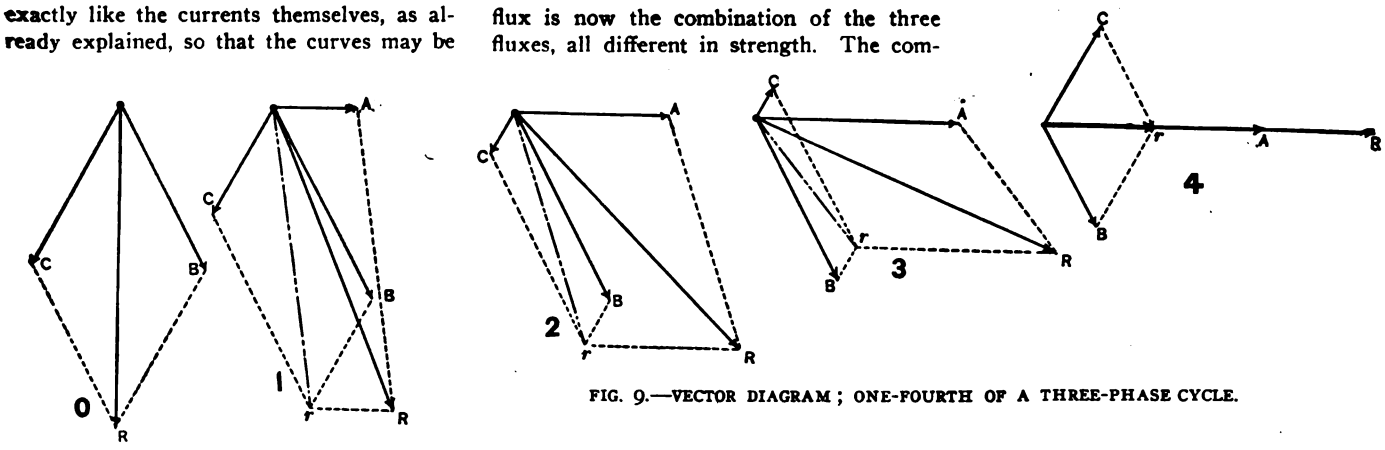


FIG. 9.—VECTOR DIAGRAM; ONE-FOURTH OF A THREE-PHASE CYCLE.

The following fundamental rules will be found useful:

If two or more coils, n in number, be arranged symmetrically about a central point in space and excited by n individual and equal alternating currents which follow the sine law of variation and differ in phase by $1/n$ of a cycle, the alternating magnetic fluxes which would be produced by the coils separately will form a resultant flux of constant strength the axis of which will rotate about the central point.

The plane of rotation will be at right angles to the planes of the coils and the rate of rotation will be equal to the frequency of the exciting currents, 60-cycle currents producing a field which makes 60 revolutions per second, and so on.

The resultant magnetic flux will be equal to $n/2$ times the ***maximum*** flux produced by one of the coils alone, provided the path of the flux is of substantially constant permeability.

Should the currents be of unequal strengths, the resultant magnetic field will not be constant but will vary in strength between $n\,\Phi_a \div 2$ and $n\,\Phi_b \div 2$, Φ_a being the maximum strength of the weakest flux and Φ_b that of the strongest flux. The rate of rotation will also be irregular, the speed of the rotating being greater in some parts of its orbit than in others; the average rate, however, will remain equal to the frequency of the supply currents.

Letters on Practical Subjects

Communications intended for publication in this department must be received at this office not later than the 15th of the month prior to the date of publication.

Mr. Notholf's Problem in Motor Operation.

To the Editor, American Electrician:

I submit what I believe to be an explanation of Mr. Notholf's motor problem as published in the November number. Had the 10-h.p. motor been fused with a 20-ampere fuse instead of one of 40 amperes, his trouble would never have occurred. When the 10-h.p. motor became stalled it was equivalent to a dead short on the line, and the time required to blow the 40-ampere fuse resulted in an excessive drop in the line voltage. This may have been caused by the slowing down of the driving power due to the overload, the slipping of the belt for the same reason, or the reduction of generator voltage due to an overload, especially if this were a plain shunt-wound machine. Now the motors being under load naturally slowed down instantly, and this in turn reduced the counter e.m.f. When the 40-ampere fuse finally did blow, the short was removed and the line e.m.f. returned to normal. The motors being under load could not instantly respond to the change and the counter e.m.f. being so much lower than the line e.m.f. a large current flowed through the armatures of the motors; sufficient in fact to blow their fuses. The reason the fuse did not blow on the 7½-h.p. motor, was because the lever of the starting box went to the "off" position when the line voltage went down. Possibly the spring was stronger or the magnet weaker on this starting box than on the others. If the 10-h.p. motor will not run with a smaller fuse than one of 40 amperes, it is evident that it is entirely too small for the work it has to do.

Ironwood, Mich. C. B. SMEETH.

To the Editor, American Electrician:

The curious result obtained by Mr. Notholf is easily explained. The excessive current taken by the stalled 10-h.p. motor, produced an abnormal drop in the line voltage between the generator and the motors. When the fuse blew, the e.m.f. instantly rose again to normal. The other motors meanwhile having slowed down somewhat owing to the decreased e.m.f. available were unable to respond quickly enough and hence took enough current to blow all their fuses, before they would speed up and develop their normal counter e.m.f.

Schenectady, N. Y. ROBERT E. NOYES.

To the Editor, American Electrician:

Referring to the problem in motor operation in the November number, I would offer the following explanation: When the 10-h.p. motor became stalled it was in effect a short circuit on the line which caused a considerable drop in voltage either from overloaded feeders or from inability of the generating plant to meet the demand under these conditions or perhaps both. The low voltage caused the other motors to slow down considerably and as the load on them was a constant quantity which did not decrease with decrease in speed, they had a tendency to likewise become stalled. This would cause an abnormal rush of current in their armatures, blowing their fuses. The starting box of the 7½-h.p. motor may have released from overload or the voltage may have affected the retaining magnet sufficiently to have caused it to release. If the load on these motors had been of such a nature that a drop in speed would have caused a considerable decrease in load as for instance when driving a fan, no overloading would have resulted. The starting boxes would however probably release from low voltage.

New York City. LEWIS C. REYNOLDS.

To the Editor, American Electrician:

Regarding Mr. Notholf's trouble with his motors, I would suggest that the 10-h.p. motor was overfused, and did not relieve the overload promptly, thus drawing an excessive current from the line, reducing the voltage sufficiently in the other branch motor circuits to release the starting box lever on one motor, which may not have had a good magnetic contact, or perhaps, due to its location with respect to the other circuits, the voltage fell to a lower value. The speed of the other motors had so materially decreased before the 10-h.p. motor fuses blew, that when the full voltage came on again, their fuses also blew.

Denver, Colo. LEWIS M. MCBRIDE.

To the Editor, American Electrician:

With reference to the letter of Mr. Harold Notholf in the November number of your paper, I might say that it would appear that the stalling of the 10-h.p. motor and consequently the momentary short circuit or overload evidently caused a drop in the line voltage thereby weakening the fields of the other motors and resulting in an increased armature current beyond the fuse capacity. The fact that the lever of the starting box of the 7½-h.p. motor fell back to the "off" position would indicate an abnormal drop of line voltage. It frequently happens that the fuses of motors when performing work nearly up to their capacity will blow when the line voltage drops to any appreciable extent. It seems to me that this is the only explanation that could be given of Mr. Notholf's trouble.

Kingston, Ont. J. HALLIDAY.

[The author of the above problem has directed our attention to an error made in deciphering his signature, which should be read Harold M. Wolf and not Harold Notholf.—EDITOR.]

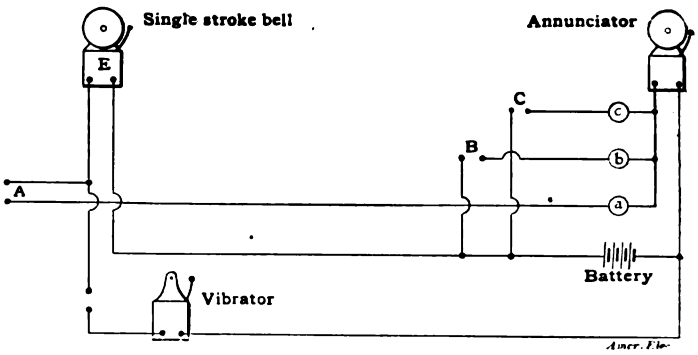
Mr. Remey's Problem in Bell Connections.

To the Editor, American Electrician:

I submit herewith a solution to Mr. Remey's problem in bell connections which appeared in the November number. A vibrating bell with bell removed or a small buzzer and a small amount of wire suffice, so that with the conditions laid down, I cannot conceive of a more practical or economical method of solving the problem. A single wire with the push and vibrator in series is connected as shown by Fig. 1. From this it will be evident that the stroke is single when operated from *A* and vibrating when operated from the push in the basement. The annunciator is not in circuit, so that it cannot indicate or ring.

Cincinnati, O. JAMES T. COBERT.

[Solutions similar to the above were also received from A. E. Ecklund, Pittsburg, Pa.; Richard Gessner, Oak Park, Ill.; C. H. Hodgkins, Providence, R. I., and J. Siddall, Kearny, N. J. We have received a number of solutions calling for an extra battery for the bell *E*, and others in which the bell *E* was arranged as a single stroke and vibrating bell combined. These are all inadmissible.—EDITOR]



MR. COBERT'S SOLUTION TO MR. REMEY'S PROBLEM.

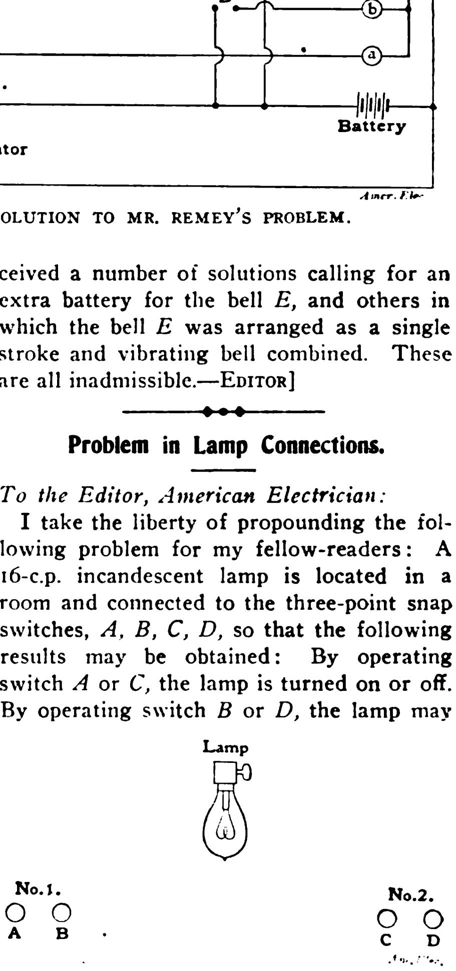
* * *

Problem in Lamp Connections.

To the Editor, American Electrician:

I take the liberty of propounding the following problem for my fellow-readers: A 16-c.p. incandescent lamp is located in a room and connected to the three-point snap switches, *A, B, C, D,* so that the following results may be obtained: By operating switch *A* or *C*, the lamp is turned on or off. By operating switch *B* or *D*, the lamp may be made to burn dimly or brightly, a 32-c.p. lamp being used as a resistance. Whatever is produced at No. 1, the contrary is possible from No. 2. How is the lamp connected?

Birmingham, Mich. L. F. MCHUGH.



PROBLEM IN LAMP CONNECTIONS.

Queries and Answers

IMPORTANT.—No attention will be given to any inquiry which does not give the full name and address of the inquirer.

What is the correct pronunciation of volt, ampere and gauss? H. C. D.

Vohlt, ompair and gowce.

Is there any way to prevent mutual induction and consequent cross-talk between two parallel ground-return telephone circuits without changing the lines to metallic circuits? P. H. W.

No.

How can I obtain violet rays from an arc lamp? (2) Is there any other way to improve an arc lamp for photographic purposes? L. R. M.

By lengthening the arc. (2) We do not know of any.

How should a three-wire circuit be fused to deliver current to 30 enclosed-arc lamps each requiring 5 amperes? W. J. McN.

Put a 75-ampere fuse in each of the three leads, if the lamps are connected 15 on each side of the neutral wire.

What causes the armature of an electric motor to revolve? C. F. H.

The attraction between the magnetic fluxes set up by the field magnet and the current in the armature wires. See the Lessons Department in the September, 1902, number of this paper.

Where can I get castings for the 4-kw. double current machine described in "Electrical Designs"? E. L. B.

We do not know of any source where they can be bought. It was intended that the reader should make his own patterns and get castings made from them.

Please give instructions for making a battery suitable for the treatment of rheumatism. W. G. P.

The faradic batteries commonly used for nervous and muscular troubles can be bought for less than the material necessary to make one would cost you—*i. e.*, from $3 up.

Is there any preference by the Underwriters as to whether service wires should enter a residence in the attic or the basement? Should the main switch, fuses and meter be put in the attic or the basement? C. D. B.

So far as we know there is no preference from the Underwriters' standpoint; we should much prefer putting the entrance in the attic.

I have made the voltmeter described in "Electrical Designs," but cannot get the magnet to hold magnetism; it is made of tool steel and hardened by heating and quenching in sal ammoniac solution. What is the trouble? H. S.

The steel is not of the right quality for permanent magnets; you will have to use either chrome or tungsten steel. The best plan is to have the magnet made by some establishment that makes permanent magnets for commercial purposes.

Where can I obtain castings for dynamos of 5 to 25 incandescent lamps capacity, with instructions for winding the machines? R. K.

We do not know of any source whence such material is obtainable. We are publishing a series of articles which will enable anyone to lay out a design and the windings for it in any size up to 16 ins. diameter of armature; these appear on the pages immediately following the editorial pages of each number.

Which is it more essential to keep steady in an alternator supplying induction motors, the speed or the voltage? (2) What is the relation between the slip of an induction motor and the current taken by it? (3) In a small sub-station supplied from a three-phase circuit and supplying chiefly a lighting load (with a few motors) is it good practice to deliver current to the distribution circuits directly from transformers of the proper transforming ratio? R. F.

The voltage, because the torque of the motors varies with the square of the voltage while the output varies with only the first power of the frequency. (2) The current varies approximately with the slip. (3) Yes.

Please give a formula for estimating the size of wire to be used in an electric heater and one for the probable rise in temperature of the heating conductor. H. H. P.

The size of conductor must be such that its resistance when hot will be equal to the voltage at its terminals divided by the current it is to carry. We know of no accurate formula for rise of temperature; the effective radiating surface varies so widely with different conditions that a general formula cannot be deduced. The only reliable way to determine the temperature rise is by experiment.

What is the resistance of the shunt field winding of a 125-kw. compound-wound generator? (2) Does the shunt resistance bear a fixed relation to the output of the machine? (3) Where can I get a table of conduit pipe sizes to be used for different sizes of wire? W. H. S.

(1) and (2) The resistance of a shunt winding depends on the ideas of the designer of the machine; there is no fixed relation for all machines. (3) There is no such table in print because the outside diameter of a given size of insulated wire varies widely. The internal diameter of the conduit must be large enough to allow the wire to be drawn through it easily.

Will a 4-pole dynamo operate with a 2-pole armature winding and two sets of brushes set at 180 degrees? (2) If not, what are the practical combinations? V. E. H.

No; the brushes would be at points of equal potential on the commutator. (2) The machine will work with the 2-pole winding and four sets of brushes 90 degrees apart, but this will give only half the normal voltage. The armature should be rewound with a 4-pole winding and the brushes arranged to correspond; if it is a small machine, use a two-path winding with two groups of brushes 90 degrees apart; if it is a large machine, use a simple lap winding with equalizing connections and four groups of brushes.

A brine pump supplying three sets of cooling coils will not keep all of the coils down to the proper temperature. The pump cylinder is 5 ins. in diameter, its discharge outlet 4 ins. bushed down to 2½ ins. The delivery pipe is 2½ ins. diameter throughout; the branch for the first coil taps into the delivery pipe a little distance from the pump and the branch to the second coil taps in farther along; the main pipe runs through to the third coil, 30 feet above the pump, and this coil is the one that is hardest to cool. The coils are all of 1½-in. pipe. How can the cooling be made equal in all the coils? W. D. W.

The delivery pipe should be the full size of the original pump outlet up to the second branch pipe junction to avoid throttling the total discharge stream; by throttling with valves the branches to the coils which give the best results, all three coils can be made to cool equally.

Please give data for an induction coil to give a 5-inch spark. (2) What form of interrupter is best for X-ray work? (3) Can the coil be excited from a 110-volt circuit? (4) Will it work if supplied from an alternating-current circuit? R. E. S.

Make the core of annealed iron wires, No. 22 gauge, 12 ins. long, 1⅛ in. diam. For battery work wind the primary with two layers of No. 12 wire wound to cover 11 inches of the core; for 110 volts use four layers of No. 16 wire and put a dead resistance in series with it. Put 7 pounds of No. 36 silk-covered wire in the secondary winding. (2) A mechanically-driven interrupter. (3) Yes; direct current. (4) Not satisfactorily; the reversals are not sufficiently sudden.

What connections should be made to the commutator of the double-current machine described in the March, 1900, number (Chapter X of "Electrical Designs") to make it a combined direct-current and single-phase alternating-current machine? (2) Would the machine give 110 volts direct and 80 volts alternating simultaneously if driven as a generator? (3) Would it overheat if operated as a direct-current generator alone? E. L. D.

Lead four taps out from four equidistant commutator segments to two collector rings; two diametrically-opposite taps to one ring and the other two taps (also diametrically opposite) to the other ring. (2) It will give 110 volts direct and about 70 volts alternating at the same time; the sum of the outputs in amperes on both sides must not greatly exceed the total rated ampere capacity of the mahine. (3) No.

Are machines built commercially to give both direct and alternating currents and to supply a three-wire system balanced with auto-transformers? (2) If so, what is the approximate ratio between the direct-current voltage and the alternating-current voltages? (3) How would the efficiencies compare operating the machine as a straight direct-current generator, a straight alternator and as a combined machine? (4) Could such a machine carry its full rated load as either a direct or alternating-current dynamo? (5) Would an 8-pole machine running at 900 r.p.m. give 60 cycles? (6) How many phases would it give? J. E. McI.

Yes; any rotary converter will do so if driven as a generator by some external source of power. (2) A three-phase machine will give an alternating voltage of about 63 per cent of its direct voltage; a two-phase machine will give about 71 per cent of its direct voltage on the alternating-current side. (3) The highest efficiency is obtained operating as a combination machine; the next highest as a direct-current machine alone. (4) and (5) Yes. (6) The number of phases depends entirely on the armature winding; the speed and number of poles do not affect that.

THE ELECTRICAL TESTING LABORATORIES.

Commercial testing laboratories have been maintained in Europe for the past ten years with marked advantage to the industries availing themselves of them. Need of such an institution has been felt for some time in this country by manufacturers, engineers and purchasers alike, and at one time it was suggested that a laboratory be maintained in New York by one of the electrical societies. Doubts, however, of financial success caused the suggestion to be dropped without trial. For two years the Lamp Testing Bureau maintained a laboratory at 14 Jay Street; but soon outgrew both home and name. The scope of its work continually increasing, it soon became necessary to enlarge its equipment, which heretofore was devoted largely to the testing of incandescent lamps, and provide apparatus for every conceivable electrical test. It then became necessary to have a corporate name more in keeping with the work done by the company and a building large enough to house the apparatus, leave room for expansion and provide comfortable quarters. Accordingly the name of the company was changed to the Electrical Testing Laboratories and large quarters were obtained at 80th Street and East End Avenue, New York City.

The laboratories have but recently been completed and as a description of them has never been published we present herewith a partial account of the equipment, giving only the most prominent divisions of the facilities already at hand. In an effort to offer a satisfactory substitute for a private laboratory, rooms have been provided for the use of those who desire to make their own tests, experiments or demonstrations secretly; the company furnishing the instruments, apparatus and current. Fig. 1 shows the switchboard controlling the motor-generator set which supplies current to the incandescent lamp life-testing racks. This set consists of a 220-h.p. 6600-volt, 25-cycle, three-phase induction motor direct-connected to a 125-volt 60-cycle alternator which is excited from a small motor-generator set the motor of which is operated by 220-volt, 25-cycle, three-phase current. The current generated by the set is at about 117 volts and the average variations in e.m.f. are restricted by means of an automatic regulator supplemented by hand control, to within ¼ volt either way and rarely exceed ½ volt. Curve drawing voltmeters supply records of pressure variations.

From the large dynamo the current is sent into an auto-transformer whence it is distributed to the life-test racks at 41 voltages ranging from 100 volts to 140 volts by steps of one volt. From a smaller auto-transformer voltages ranging from 25 to 300 may be obtained. These are supplemented by small portable auto-transformers. For the testing of series burning lamps a constant current transformer is provided.

Fig. 2 shows one end of the room where incandescent lamps are tested to determine their useful life and candle-hour value. To prevent drop, and consequent variation of pressure with the load, the conductors from the transformers to these racks consist of large copper bars, as shown across the top of the engraving. There are about 6000 receptacles arranged in groups for operation at various potentials. Each receptacle is so arranged that a small resistance can be inserted in its circuit to adjust the pressure to one-tenth of a volt where necessary. Most of the lamps are burned in a horizontal position to develop their tendency toward dropping, if such weakness exists, and every effort is made to determine their faults without submitting them to any unusual strain. A card at each receptacle shows all the data necessary to identify each lamp. At present there are about 2500 lamps burning on the life-test racks.

In adjoining rooms on the same floor are located photometers which are used to determine the candle-hour performance of incandescent lamps under test. Six photometers have been provided for routine work in this connection, and are supplemented by other photometric apparatus designed for the more special work which it is necessary to do in connection with life-tests upon incandescent lamps. All of these photometers have been built specially for use in these laboratories, and are adapted to work of a high degree of accuracy and possess as well great ranges of usefulness. Each is connected separately to a switchboard, to which the various available sources of current supply are also brought, connections being made by means of flexible cable. This makes available for use in con-

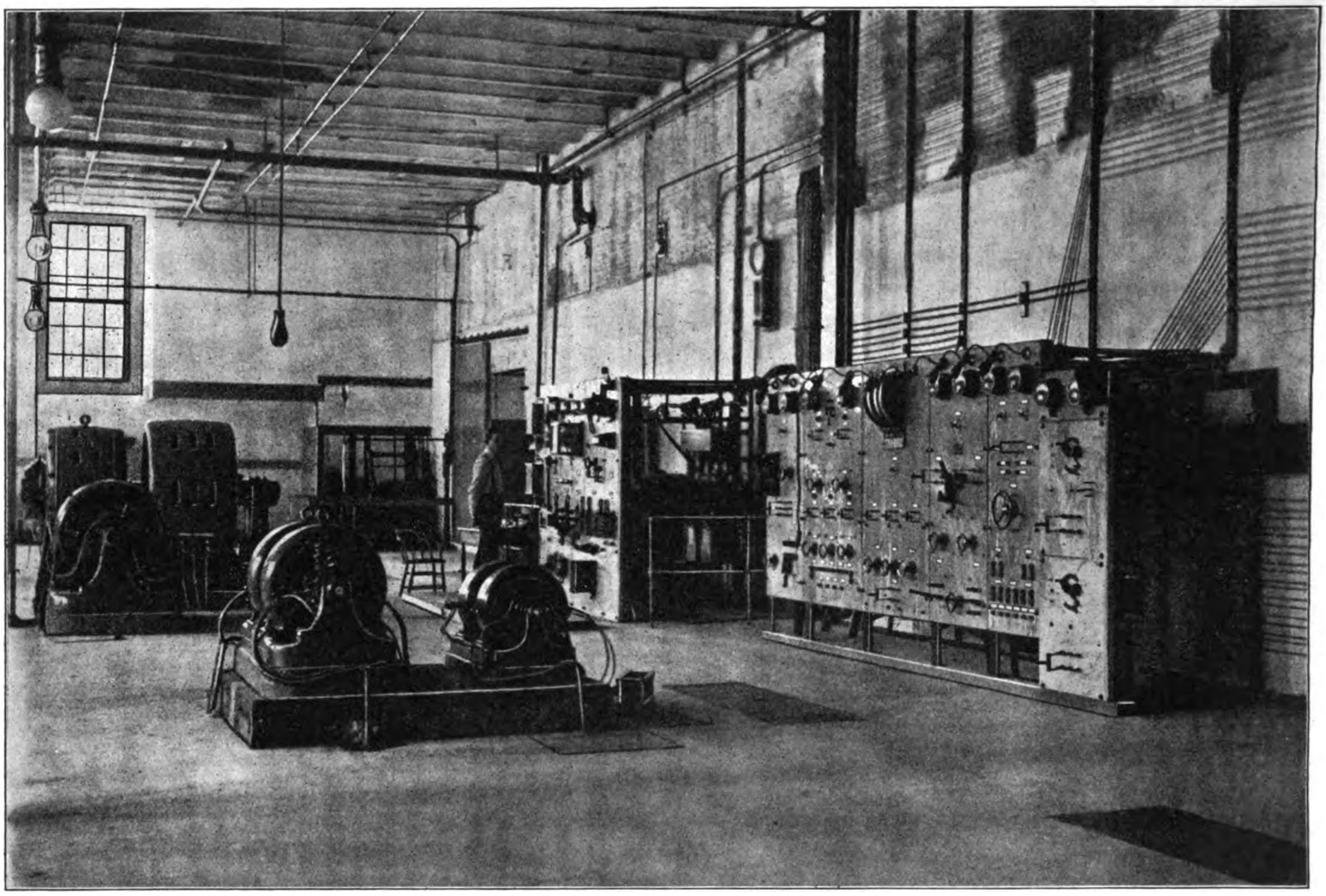


FIG. I.—MOTOR-GENERATORS AND SWITCHBOARDS FOR LAMP TESTING AND STORAGE BATTERY CIRCUITS.

nection with this work nine different storage batteries of various potentials and capacities, as well as the three-wire Edison system and the various sources of alternating current supply. Storage batteries are, with rare exceptions, used for supplying the current for photometric purposes, since where high accuracy is desired, only the steadiest possible pressure is satisfactory. All of these batteries and several others are connected to the switchboard shown in the right of Fig. 1, in the foreground of which may be seen two Crocker-Wheeler motor-generator sets for charging and discharging some of the batteries.

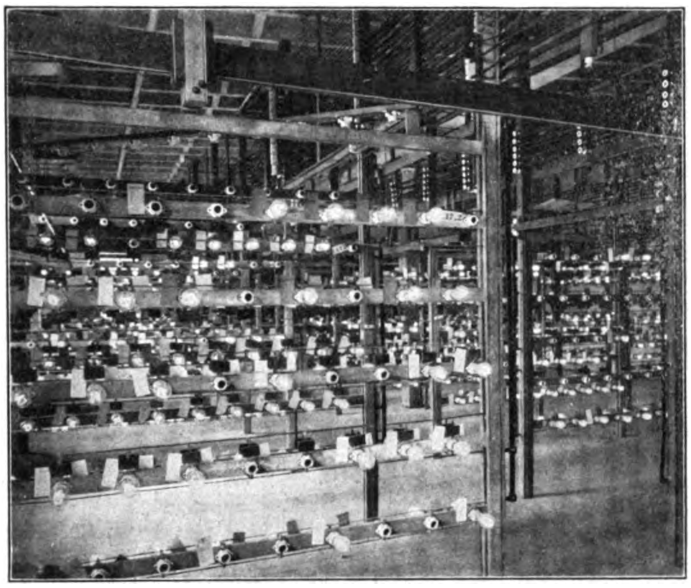


FIG. 2.—INCANDESCENT LAMPS ON LIFE TEST.

Records made in the life-test rooms in the photometric laboratories are taken to the computing room, where they are permanently entered in suitable record books, from which candle-hour values, efficiencies and other data are computed and reports prepared. Arrangements are such that candle-hour tests are conducted by three separate departments, the first two of which are very largely ignorant of the data of these tests since only a few individuals in the computing department know of the results obtained.

The arc lamp photometer equipment is particularly interesting. There is an overhead track from which arc lamps are suspended while burning on life test, one end of which terminates in the photometer. This provides a means for placing the lamp in the photometer with the least loss of time and without interfering with its conditions of burning. The lamp is hung in the centre of a ring of mirrors, 15 degrees apart, so arranged as to focus the light at any point within the scope of the photometer which is about 70 feet long. The photometer bar is mounted on a track and travels the length of the room so that it can be fixed at the best distance for the lamp under investigation: nearer the mirrors for lamps of small candle-power and farther away for larger ones. The general arrangement is after the plan of Prof. C. P. Matthews of Purdue University, who gave much of his time to the design and installation of this apparatus. A recording device is attached to the standard lamp carriage which greatly facilitates the rapidity of making readings. Altogether this arc lamp photometer provides a means for measuring with promptness and accuracy the mean spherical or hemispherical candle-power and distribution of light of arc lamps and the determination of the quality of arc lamp carbons. From the measurements obtained a curve is made showing the distribution of light.

The general photometer equipment is most complete and comprises several types of instruments for many kinds of work, from spectrophotometry to the measurement of the distribution of light by shades and reflectors used with either electric light or gas.

Fig. 3 shows the large rotating mirror device which is used in connection with a photometer for determining the distribution of light about large sources. Its use in confined chiefly to the determination of distribution of luminous intensity about large reflectors or clusters of reflectors, large globes used with either gas or electric lamps, and other large sources of light. In the illustration, a cluster of five incandescent lamps backed by a 13-inch reflector is shown in position, ready for measurement. The device is also used in connection with arc lamp photometry, supplementing the arc lamp photometer described in another paragraph. The apparatus consists of three mirrors, each 22 inches by 31 inches, so mounted that they may be placed at any angle with regard to a certain centre of rotation. The light from the source is reflected from the last mirror in the series to the photometer, always falling perpendicular to the photometer disk. This last feature is of great importance, since with Bunsen or Leeson disks considerable photometric error is introduced if the light falls upon the disk at an angle which varies materially from the perpendicular, which would be the case if a single mirror were rotated about the source of light.

The photometry and life test of Nernst lamps has been provided for by the construction of special apparatus for burning the lamps in a pendant position and taking their candle-power readings without interference with their life test, and with the least loss of time.

There are many types of incandescent lamps on the market designed for special uses. In some the filament is arranged to give the most light in a horizontal plane, in others the aim is to project the light downward; another type claims to afford an equal illumination in every direction. All of these lamps are usually compared in terms of spherical candle-power or total flux of light. Generally such comparisons require considerable labor and skill. The Electrical Testing Laboratories use for such purposes the integrating photometer of Professor C. P. Matthews, which gives with one measurement the mean spherical candle-power of any type of lamp and affords an accurate comparison of the various types on the market. This photometer has been illustrated so often that a description would be superfluous.

To keep all of the photometers in accurate agreement with recognized standards, a standardizing photometer is installed in a separate room with a potentiometer, standard voltmeter, standard ammeter, standard cells and resistance standards; a complete photometric laboratory in itself which can, if necessary, be checked against the standardizing laboratory on the floor above. On this photometer the most accurate work is done, such as the checking of standards against the amyl-acetate and the pentane standards, and the calibration of secondary standards of which the company issues a considerable number. These standard lamps are used by lamp manufacturers, educational institutions and photometrists generally, and are said to be in agreement with the recognized standards authorized by the government laboratories of Europe and America. A spectrophotometer is installed for the purpose of comparing the colors of different lights, such as the carbon arc, the carbon incandescent and the Nernst.

Fig. 4 shows one corner of the general laboratory on the top floor. It contains the instruments of precision by which other apparatus is kept in agreement with recognized standards. In this room are made such tests as the conductivity of wires, insulation of conductors, resistance measurements, checking of standards of e.m.f., current and resistance and work requiring high accuracy. In such work, when the humidity of the air is excessive, trouble is encountered from the moisture which condenses on instruments and their connections, decreasing the insulation and in many instances reducing the accuracy of the tests. To obviate this a refrigeration system is provided, one of the coils of which is enclosed in a box near the ceiling, as shown in the illustration, and so ar-

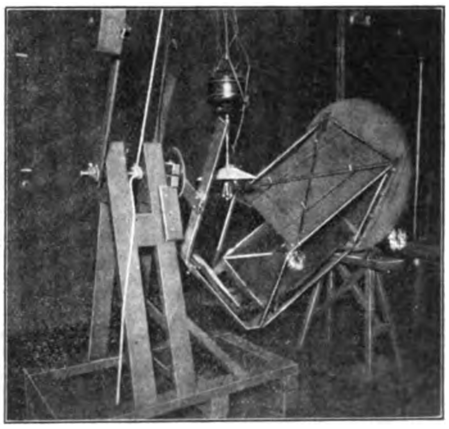


FIG. 3.—ROTATING PHOTOMETER MIRROR.

ranged that the excess moisture can be frozen out of the air. This artificial drying of the air enables accurate work to be done, when otherwise it would be impossible, and is especially important in the calibration of standard voltmeters and ammeters.

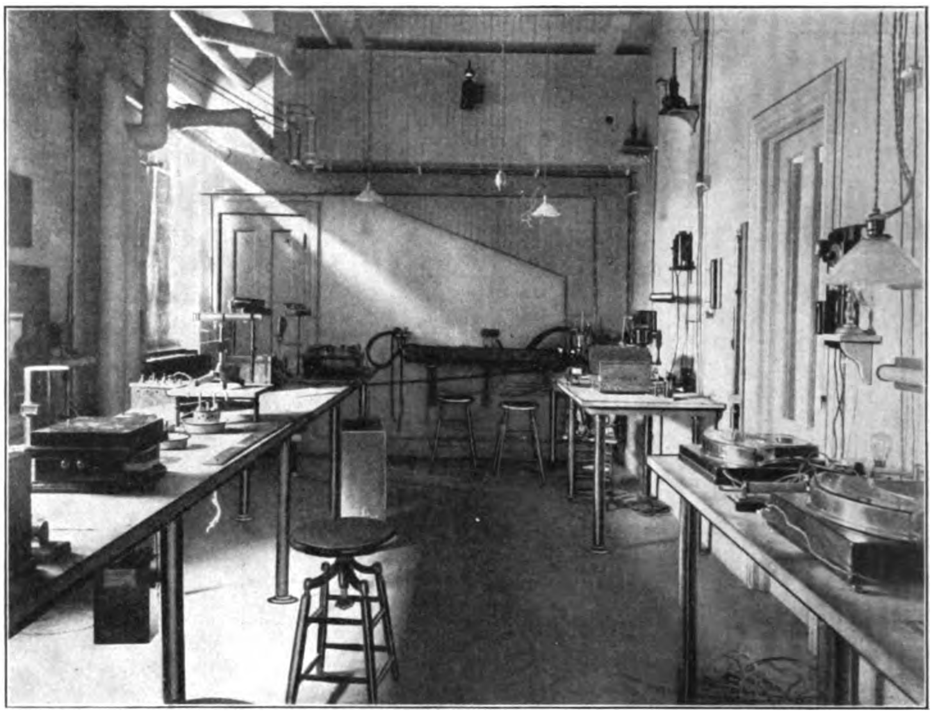


FIG. 4.—CORNER OF GENERAL LABORATORY.

The floor of this room, as well as the general laboratory floor, is covered with linoleum, the tables are of stone on iron legs. One end of the standardizing laboratory is partitioned off to form a constant temperature room, where tests may be made at desired degrees of heat from the lowest limit of the refrigeration apparatus to the limit of high temperature imposed by personal endurance or fire hazard.

In the machinery room on the lowest floor is a special alternating current testing set consisting of two small revolving field alternators driven by motors. The shafts of the dynamos can be coupled so that they can be driven by either of the motors at various speeds to obtain frequencies from 10 to 140 cycles. Leads are brought out for one, two, three, six and twelve phases and by shifting the stationary armatures of the two dynamos and changing their relative positions any phase relation and the power factor can be had at will. This set is of great value in testing integrating wattmeters, checking indicating instruments and in such work as requires alternating current conditions similar to those on the customers' circuits. With this set almost any commercial conditions can be reproduced.

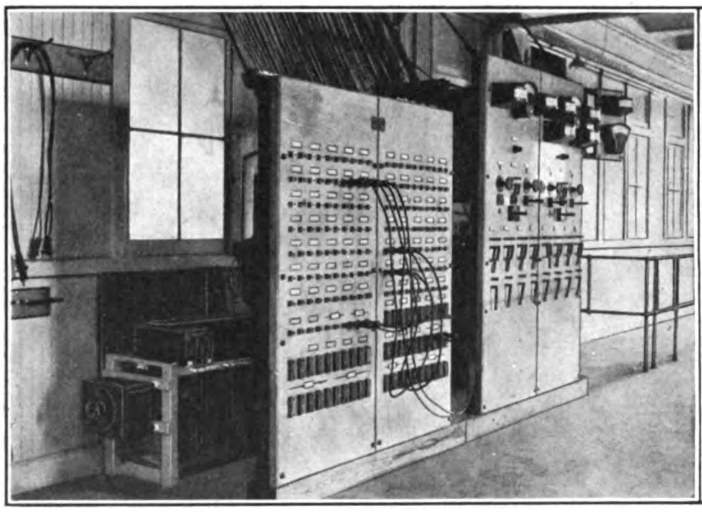


FIG. 5.—SWITCHBOARD FOR DISTRIBUTING ALTERNATING CURRENT TO TESTING CIRCUITS.

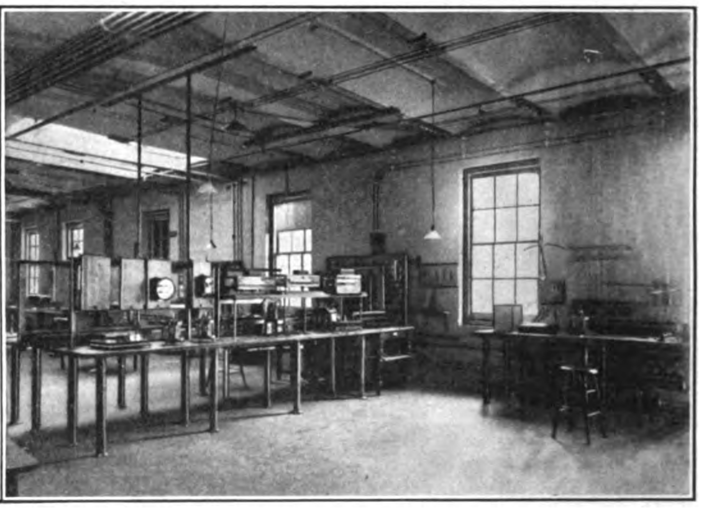


FIG. 6.—HEAVY CURRENT TESTING TABLE.

Fig. 6 shows the table for testing integrating wattmeters and instruments requiring heavy currents. Two stone top tables, built by the Albert & J. M. Anderson Mfg. Co., are provided with heavy bars of copper arranged so that the instruments under test can be cut into circuit in series with certified standards. The table is supplied with current up to 5000 amperes from four large storage cells, which can be arranged in series or multiple, or from a transformer of low voltage and high amperage capacity, and from any other source in the laboratory. Four Kelvin balances are provided as standards of alternating current amperes. The current is controlled by suitable rheostats, some of metal strips, others of carbon plates the whole making what is doubtless the best arrangement for the checking of meters and instruments requiring heavy currents. This outfit is especially useful in making tests of the accuracy of electricity supply meters under various conditions of load, voltage, frequency and power factor.

The same illustration shows a smaller table for the checking of the voltage on the various racks in the life-test room. It is extremely necessary that the average voltage delivered to the lamps on life test be as nearly correct as it is possible to keep it. There is no standard of alternating current voltage; no such means as we have in the potentiometer for determining the value of an alternating current e.m.f. Yet the voltage at the lamps must be kept right. There are several reliable instruments which read both alternating and direct-current volts, and these are used as transfer instruments, being first carefully calibrated on direct current by means of the potentiometer and then used to compare alternating with direct current. Seven methods are employed to standardize the alternating current life test voltage, all of them referring back to the standard cell and potentiometer.

For determining the wave form given by an alternator, the wave-meter is used, which gives a record from which an exact analysis of the wave form can be recorded photographically, or as a curve on cross-section paper. An important instrument which has been provided is an oscillograph. This instrument is used for making a record of rapidly varying currents. It will give a picture of the exact form of an alternating current wave of the fluctuations of a direct current due to commutation, of surging and resonance phenomena in transmission lines and the charge and discharge currents of condensers, of surges produced by opening circuit breakers, etc.

Liberal equipment is provided for making tests of insulators and insulating materials. Transformers of various sizes provide facilities for puncture or breakdown tests as high as 120,000 volts, and a special set of dynamos, operated by a motor, affords direct current at 10,000 volts for such breakdown tests as require a direct current. High tension tests are made on insulators, insulating joints and plugs, strain insulators, tape, cloth, rubber, fibre, condensers, special compounds, slate, marble, stone and many specialties in the insulator and insulation lines. Special ovens are also in use for making life tests of insulating materials at high temperatures to determine the rate at which the samples deteriorate with heat.

In the construction of dynamos, motors and transformers it is desirable that the iron shall be the best procurable for the purpose. It must have high permeability and low hysteresis. The magnetic value of iron can be determined only by systematic testing. Tests of this sort, while very simple in theory, are beset with such pitfalls that they can be safely intrusted only to an expert who has at his disposal the most approved apparatus for the purpose. In view of these facts, the apparatus and methods of the Electrical Testing Laboratories have been selected with special care. Two permeaters have been installed—one the Koepsel permeater, which enables these measurements to be carried to a reasonable degree of accuracy and with great rapidity—and the other the Picou permeameter, which, while not so rapid of manipulation, gives results of the highest accuracy. Test pieces for these permeameters can be in the form of straight bars or little piles of sheets. The necessary apparatus for testing by the ordinary ring method is installed and ready for use.

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THE SILENT CHAIN FOR DRIVING MACHINERY.

The Morse Chain Company, Trumansburg, N. Y., has made a special study of the application of silent chain driving to severe and limiting conditions which have given trouble with any other method of driving. As a result of thorough and exhaustive investigation, the company has perfected a chain for machinery driving which is said to be adaptable to any class of service whatever. The claims for this chain are that it is not affected by high-speed, very hot or dry atmosphere, or moisture, and will run satisfactorily with but little lubrication. It is stated that in practice the chain does not wear rapidly even when subjected to the most severe extremes of dust, dirt and grit imaginable.

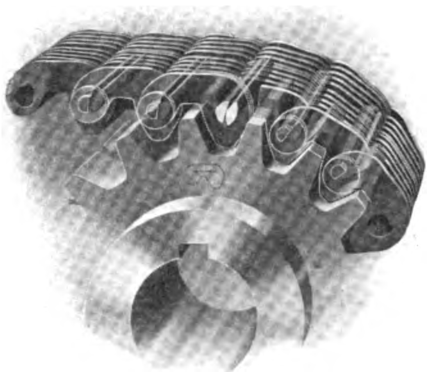

FIG. 1.—MORSE SILENT CHAIN.

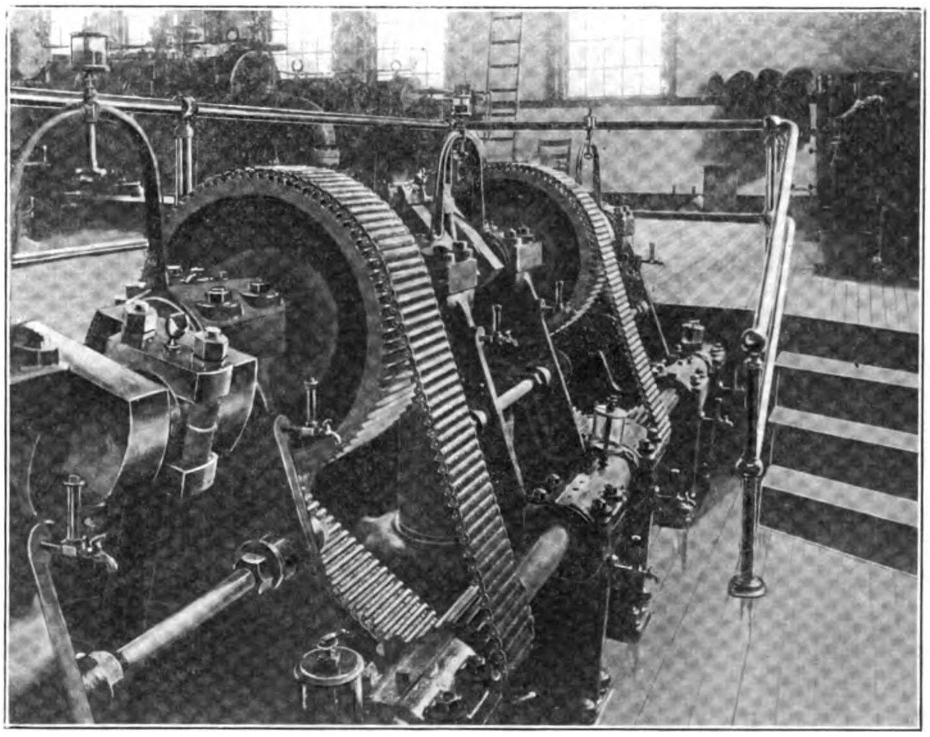

FIG. 2.—CHAIN DRIVE FOR CONDENSER AIR PUMP.

The important feature is that its efficiency in transmission of power is very high, being by actual test from 98½ to 99 per cent.

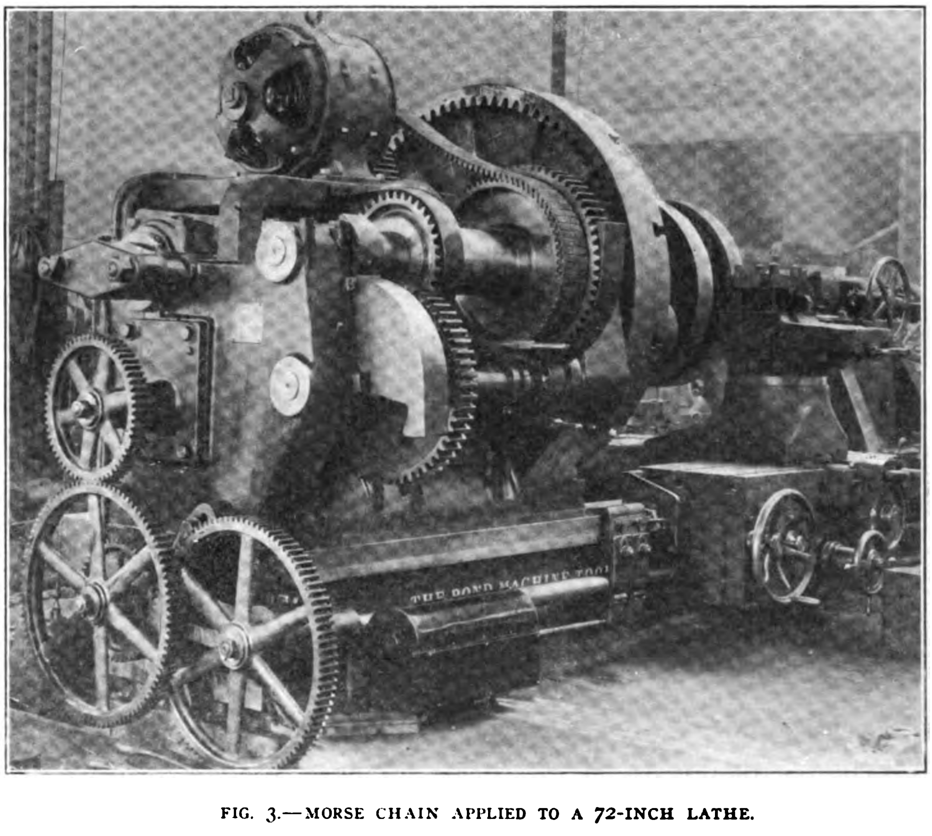

FIG. 3.—MORSE CHAIN APPLIED TO A 72-INCH LATHE.

The construction of the Morse Silent Chain is shown in Fig. 1. The joint consists of two pieces of hardened tool steel, so shaped and arranged that one piece rocks or rolls on the other as the joint passes on and off the sprockets. The two rocking parts of the joint are fixed in opposite ends of the links, and it is claimed that there is only a pure rolling friction on hardened tool steel surfaces with ample contact area to withstand the pressure and that consequently there is no tendency for the joint to wear and cause the chain to lengthen. To prevent undue vibration under high speeds, with the consequent wear, the rocker pins of the high-speed silent running chain are so shaped that the areas of contact surface are greatly increased when the chain is drawn straight between sprockets, in which position a broad bearing is given. The two-part pin used in the Morse rocker joint permits of an unbroken contact the whole width of the chain, less the outside links. As the rocker joint is subjected only to rolling friction it does not require lubrication, and the speed limit is therefore not fixed by the point at which the centrifugal force will throw off the lubricant. A paste grease, sufficiently heavy so that it will not be thrown off at high speeds, affords proper lubrication for the chain in its contact with the sprocket teeth and between the plates of the chain itself. As the pressure between each chain link and sprocket tooth is inversely proportional to the number of teeth in contact with the chain, and as this number is large, the pressure is small.

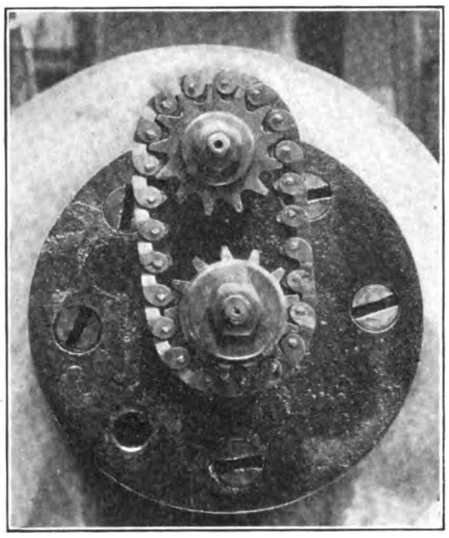

FIG. 4.—CHAIN RUNNING GRINDER ON LARGE BORING BAR.

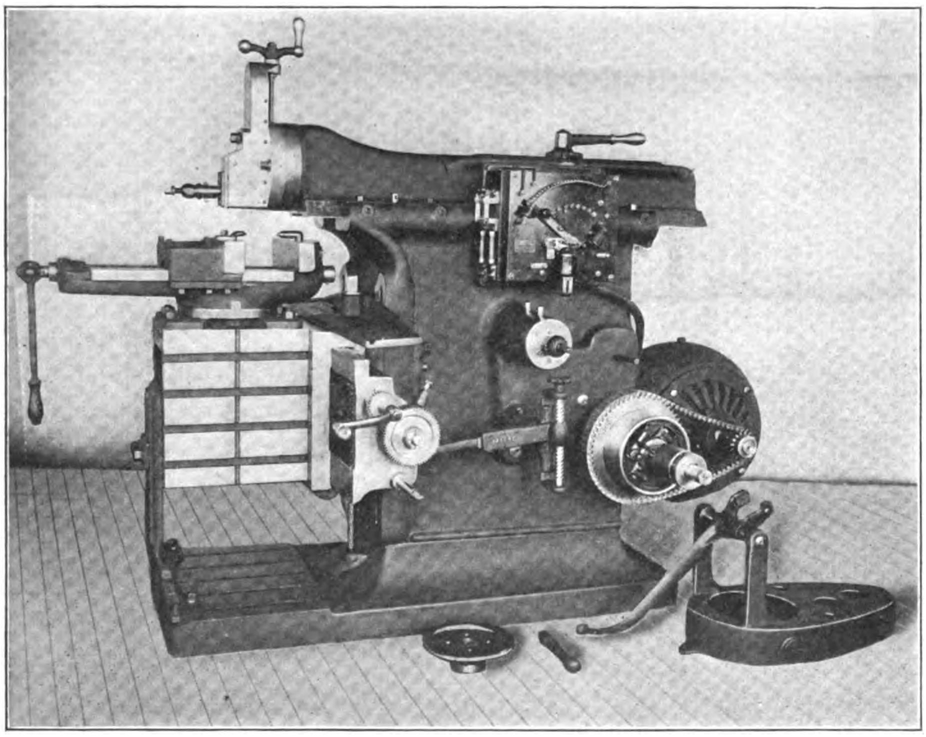

FIG. 5.—MOTOR-DRIVEN EXTENSION-BASE SHAPER.

The sprocket wheels are made of high-grade cast-iron, accurately cut, and in use are found to show little or no wear. For exceptionally hard service or when there is little metal around the shaft, hardened steel sprockets are used. To guide the chain in its passage on the sprockets, special guiding links are used which project below the balance of the chain into grooves turned in the sprockets. The holes in the opposite ends of the links are punched to conform in shape to and securely hold in the large end of the link the rocker pin, and in the small end the seat pin, there being no motion between either part of the joint pin and link. The outside links are bent laterally so that the large end comes under the small end of the adjoining link to permit of the proper engagement with both seat and rocker pin. The joint pins are made of the best grade of tool steel carefully hardened, the shouldered ends of the seat pins being softened to permit of being riveted in the outside links, or in washers in the larger pitches, to hold the chain together.

The accompanying illustration (Fig. 2) of two chain drives from a motor-driven shaft to two condensing pumps illustrates the use of the Morse silent chain under conditions where belts could not possibly be used. These chains were introduced here to replace gears formerly used, on account of the noise of the latter. The maximum pull on the chain is 10,000 lbs. which alternates to 300 lbs. negative pull at each stroke, due to the intermittent action of the pumps, but over two years' service shows no depreciation. Fig. 3 shows the application of a chain drive from a 15-h.p. variable-speed motor to a 72-in. lathe. The compactness and convenience of this arrangement is an interesting feature. Fig. 4 illustrates the use of the Morse chain for driving a grinder on a large boring bar. The chain speed in this case ranges as high as 1150 feet per minute. It operates noiselessly, and its compactness is readily discernible. Fig. 5 shows the application of a Morse chain to a motor-driven shaper.

A NEW MOTOR SPEED CONTROLLER.

For controlling the speed of a constant-potential motor, the advantages of variable applied e.m.f. over rheostatic control are too well recognized to require enumeration here. In alternating-current work, variable voltage is easily obtained by means of transformers, but in direct-current practice it has been necessary either to employ a motor-generator to supply each motor with variable voltage or to install a multi-voltage generating and distribution system. The American Electric & Controller Company, New York, has developed a controller which is designed to meet the requirements of variable-speed work by means of variable voltage without resorting to either of the expedients mentioned. Fig. 1 gives a view of the latest form of this controller and Fig. 2 is a diagram of connections for it. The underlying principle of the apparatus is the variation of effective power in an electric circuit by supplying the power intermittently, varying the proportion of the total time during which the motor actually receives power from the supply circuit.

In series with the armature of the controlled motor is connected a combination of contact bars resembling an ordinary dynamo or motor commutator; this is the "interrupter," and it is rotated at a constant speed of 1500 r.p.m. by a small motor mounted directly on the lower end of the shaft on which the interrupter is mounted. Two groups of ordinary carbon brushes, fed in reaction brush-holders, are in con-

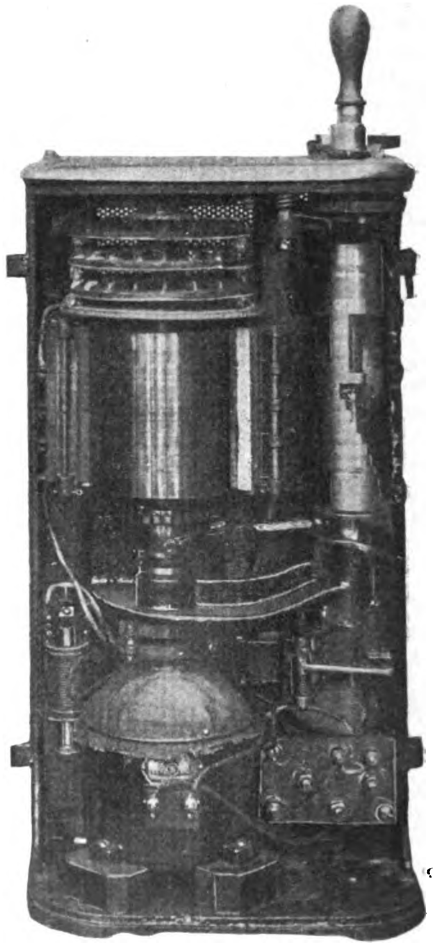

FIG. 1.—MOTOR SPEED CONTROLLER.

tact with the interrupter at diametrically opposite points; these are the terminals of the interrupter. The bars of the latter are arranged so that more or less of them can be put into the circuit, thereby varying the length of time the circuit is interrupted during each revolution of the interrupter; the fewer the number of segments connected in, the shorter the length of time the circuit is closed during each revolution and, consequently, the less energy is received by the motor, since energy is the product of power × time. A peculiar feature of the apparatus, however, is that the rapid interruptions of the circuit not only reduce the energy delivered to the motor by reducing the time of application per revolution, but they also reduce the voltage at the brushes of the motor, thereby reducing the power as well as the energy. The torque of the motor is not reduced at all, so long as the load is such as to keep the current at the same value, for the reason that the torque is directly proportional to armature current × field strength, and the latter is constant within the working range of the interrupter.

The interrupter itself gives a speed range of two to one; for further range, field control is employed. The controller handle operates a small contact cylinder which controls the various circuits with the following results: First, the motor driving the interrupter is put in circuit; next the working motor is connected to the supply circuit with the field winding directly across the circuit and the armature in series with the interrupter, of which the smallest number of segments is now active; this starts the work motor at its lowest speed, the impressed voltage being minimum. The next move of the controller handle increases the number of interrupter segments in circuit, thereby increasing the impressed voltage and increasing the speed of the work motor; further movement increases still further the number of active interrupter segments, until all are finally in circuit except a few which always remain dead in order to interrupt the circuit during each revolution. The next movement of the handle short-circuits the interrupter and leaves the work motor running as a plain shunt machine at full voltage; the little motor driving the interrupter is left in circuit at this point to keep the interrupter revolving "dead" under the brushes and allow it to be polished. The next move cuts out the interrupter motor and inserts resistance in the field circuit of the work motor; successive movements insert more and more resistance in the field circuit, giving the additional speeds by field control in the ordinary manner. The speed gradations are almost imperceptible within the range of the controller, there being no "jumps" or abrupt changes whatever.

The controller is equipped with both undervoltage and overload safeties; the small magnet on the right of the diagram releases a spring-opened switch in the main circuit when the voltage drops or fails and the magnet on the left "kills" the one on the right when the current becomes excessive.

Sparking at the brushes of the interrupter, as the main circuit is opened by the "live" segments leaving the brushes, is reduced to a negligible point by the use of inductance or "choke" coils connected to the segments; these coils are mounted in between the discs shown at the upper end of the interrupting commutator.

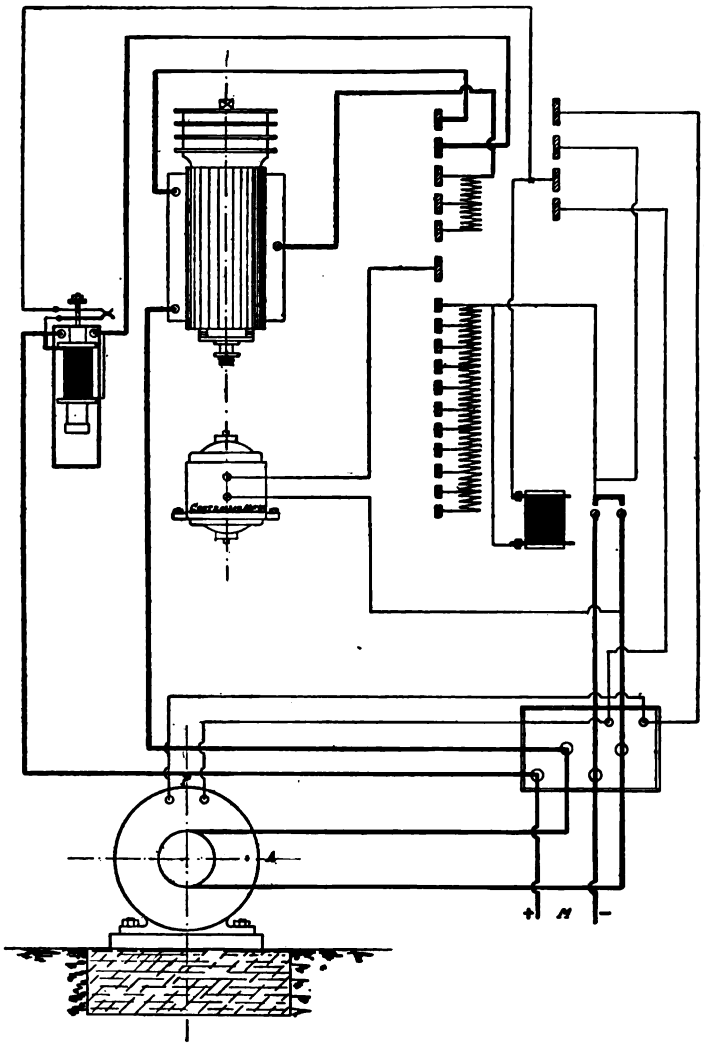

FIG. 2.—DIAGRAM OF CONTROLLER CONNECTIONS.

The controller is fitted with a reversing switch similar to that used on street railway motor controllers and interlocked with the main controller spindle in the same manner, so that the controller handle cannot be turned from the "off" position when the reversing switch is not in proper position for either forward or backward running, and the reverse switch cannot be thrown while the controller handle is at any other point than the "off" or standstill position.

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AUTOMATIC BLUE PRINTING APPARATUS.

Fig. 1 illustrates a very compact outfit for making large blue-prints which has been perfected and marketed by the Pittsburg Blue Print Company, Pittsburg, Pa. The apparatus here shown comprises a cylindrical glass holder, divided into two semi-circular parts and provided with spring clips which hold the drawing, blue-print sheets and canvas backings in place on the glass sheets. The cylindrical frame is mounted on a cast-iron base provided with rollers so that the frame may be revolved about its vertical axis for "loading." The light for printing is supplied by an arc lamp suspended from chains which pass over guiding rollers to a set of sheaves on the vertical baseboard mounted on the pillar shown at the left of the printing cylinder. A small electric motor on the vertical baseboard draws one pair of the operating sheaves up or lowers them, according to the requirements; when the sheaves are drawn upward, the lamp chain is hauled in and the lamp raised, and vice versa. The chief object in using the operating sheaves is to obtain a reduction in travel; the traveling sheaves move only about one-third the distance through which the arc lamp travels. The motion is reversed automatically by means of a nut on the screw which draws the traveling sheave up and down, this nut operating a reversing switch at the top and bottom limits of its travel. The whole operating mechanism is based on exactly the same principle as the Sprague-Pratt elevator hoisting machine.

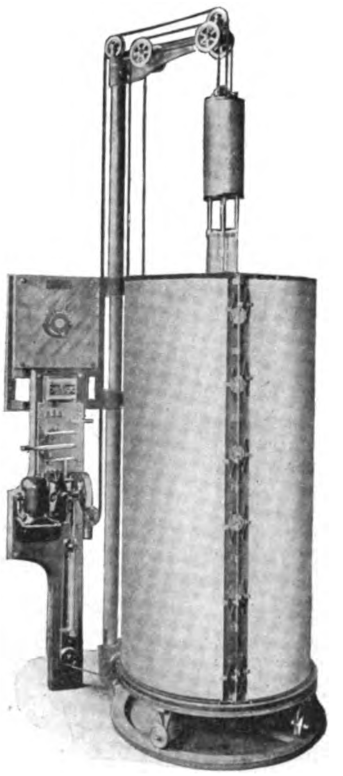


FIG. 1.—BLUE-PRINTING APPARATUS.

New Apparatus and Appliances

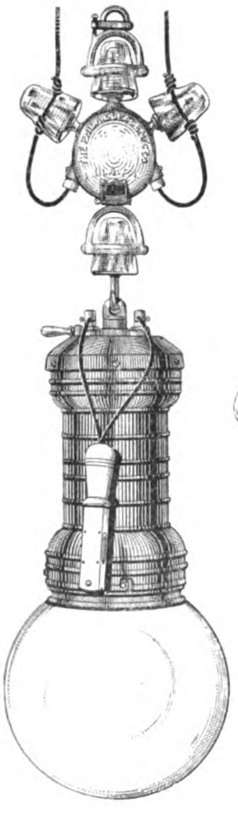
PATENT TAP AND REAMER WRENCH.

Fig. 1 herewith shows the Nichols patent tap and reamer wrench manufactured by the J. M. Carpenter Tap & Die Company, of Pawtucket, R. I. The wrench is made of drop forged steel and has hardened tool steel jaws. No pin, wire or other complement is needed to tighten its jaws on the tap or reamer, the hand alone being sufficient. Its construction is clearly shown in the illustration. The handle does not rotate so that the grip on the tap or reamer is not loosened when once fastened. The wrench is made in five sizes, the whole lengths varying from 7 to 30 ins.

FIG. 1.—NICHOLS PATENT TAP AND REAMER WRENCH.

IMPROVED CUT-OUT.

Fig. 2 herewith shows the "absolute" cut-out made by the Philadelphia Electrical & Manufacturing Company, Philadelphia, Pa. The cut-out is designed for use on either direct or alternating current and is unique in that the lamp can be entirely disconnected from the line. The enclosing case of the switch is made of galvanized cast-iron and the other metal portions of the switch such as the hook, hanger, etc., are made of brass. The handle or plug to which the lamp is attached is made of porcelain, so that the insulating qualities of the switch are not lacking. Reference to Fig. 3 will show how by simply pulling the handle out of the switch the lamp is disconnected from the line, and also the impossibility of cutting out the lamp without first closing the line, and vice versa the impossibility of opening the line without cutting the lamp in. The switches are made in two styles as shown in the illustrations, Fig. 4 being intended for attaching permanently to the pole or cross-arm, and for testing purposes also.



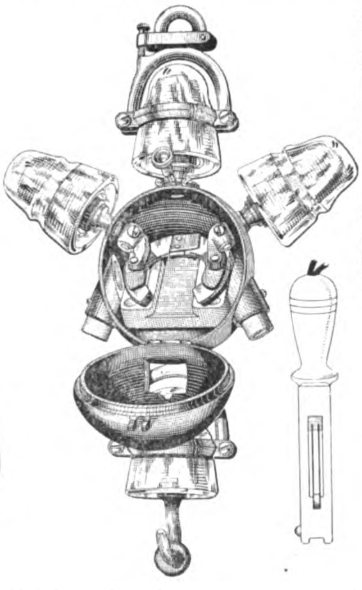


FIG. 2.—IMPROVED CUT-OUT—FIG. 3.

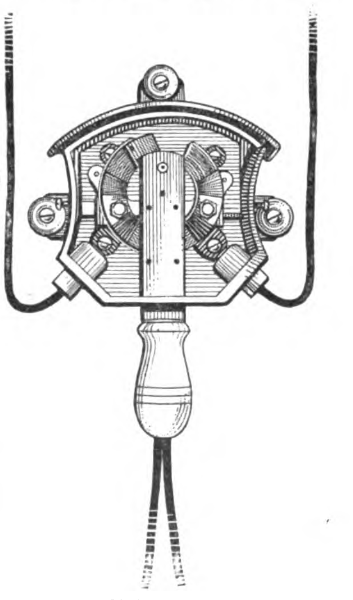


FIG. 4.—STATIONARY TYPE OF CUT-OUT.

BIPOLAR ENCLOSED DIRECT-CURRENT MOTORS.

The Emerson Electric Manufacturing Company, of St. Louis, Mo., has brought out a line of enclosed bipolar motors for direct current ranging in size from 1-20 to 1/6 horse-power. These machines are spherical in form and have a removable shutter giving access to the commutator and brushes. The field rings and poles of these motors are cast solid, and the field coils are form wound, taped, dipped and baked. The armature is made up of laminations of soft steel, pressed on the shaft and secured by collars pinned to the shaft which is of tool steel. The commutator is well made and the leads from the armature coils are protected by a wrapping of fine cord. Square carbon brushes are used with cartridge type holders of special design. The field leads on both the shunt and series motors are brought out through an insulating bushing in the frame, and all connections to brush holders are made outside the motor. These types may be readily reversed without removing the shutter. The motors are self-contained, no starting box being required. They are wound in two frames of similar design, but differing slightly in dimensions. Motors in either frame can be wound, shunt or series, for three speeds. Shunt windings in the smaller frame develop from 1-20 to 1-12 horse-power, at speeds from 1800 to 3000 r.p.m.; in the larger frame from 1-10 to 1-6 horse-power at speeds from 1500 to 2000 r.p.m. The highest speed windings, however, are not recommended for continuous service under full rated load.

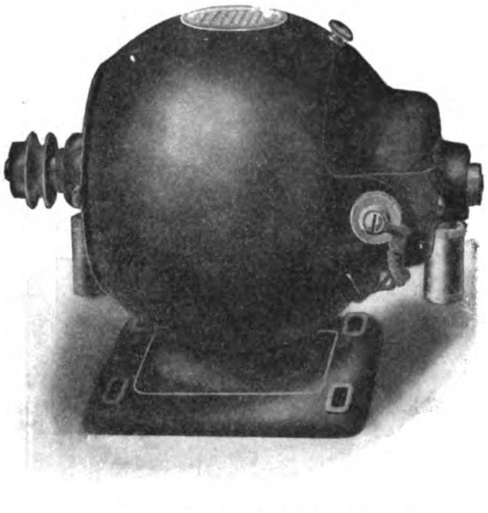


FIG. 5.—EMERSON ENCLOSED MOTOR.

COMBINATION SWITCH AND PLUG CUT-OUT.

A new line of combination switch and plug cut-outs has just been placed on the market by H. T. Paiste Co., Philadelphia, Pa., called "P-K" panel cut-outs. These comprise 25 and 30-amp. mains for 125 and 250-volt circuits, and single and double branches for both two and three-wire systems. In addition to the six styles of cut-outs in this line, the company furnishes oak panel-box fronts complete with rim locks and key, or the wooden panel-boxes entirely separate from the fronts. These boxes are lined with 1/8-in. asbestos board, and are all ready for setting into the studding. With this line of material at his service, the wireman can build his own panel boards of any number of circuits. The material is said to be approved by the National Board of Fire Underwriters.

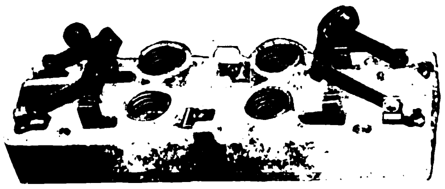


FIG. 6.—SWITCH AND CUT-OUT.

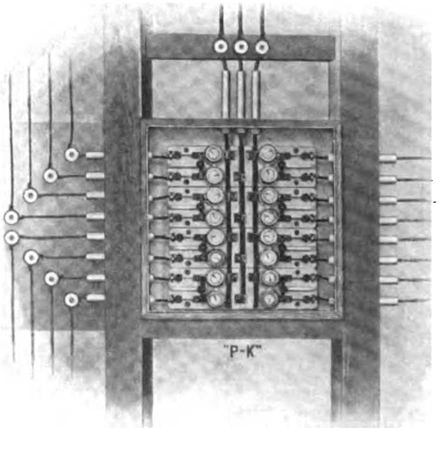


FIG. 7.—PANEL BOARD.

TRANSFORMER FOR THAWING OUT FROZEN WATER PIPES.

Although the application of electricity for thawing out frozen water pipes is not a new idea, it is only within the past few years that it has generally been adopted by central stations. During the severe weather of last winter this method seems to have received an astonishing impetus. Station managers who started out in a small way to thaw pipes to accommodate customers, in a short while found themselves overwhelmed with requests for relief from plumbers' bills and expensive excavations. The General Electric Company, in response to a general demand and realizing the superiority of electrical thawing over the old, inefficient and expensive method of opening the frozen ground and applying fire externally, has developed a transformer outfit for this special purpose, which can be easily connected to alternating current circuits in the vicinity of frozen pipes. The outfit has been designed to stand rough handling and outdoor service, and adjustments over wide ranges of both secondary voltage and current are readily made. The transformer is designed to operate on circuits varying from 2000 to 2300 volts, 60 cycles, and its secondary voltage and current may be readily adjusted from 0 to 75 volts and 0 to 400 amperes by means of an adjustable core or flux shunt controlled by a hand wheel and locking device. The transformer core has three horizontal legs with a closed magnetic circuit at the ends. Flat pancake coils are threaded on the middle legs and spaced apart so as to permit an adjustable flux shunt to move up and down between the primary and secondary coils. This device constitutes a bridge arranged to shunt a varying amount of the primary flux out of its normal path through the secondary coil. When the shunt is in the lowest position it diverts the primary flux from the secondary coil, and when it is in its highest position permits practically all the flux to thread the secondary coil; while at intermediate positions corresponding amounts of the flux thread the secondary coil. This construction affords a simple and convenient method of obtaining any voltage and current from zero to maximum capacity. Fig. 8 shows its construction and the simple method of controlling the flux shunt. The leads of the primary coil are brought out to a suitable connection board, on the side of the transformer, on which are mounted primary switches, fuses and an ammeter. The terminals of the secondary coil are brought out to heavy lugs, at the end of the transformer, from which heavy cables can be run to the proper pipes to be thawed. The outfit complete, including transformer, switches, cover and meter, weighs approximately 1200 lbs. It is mounted on four broad flanged wheels to permit its being quickly loaded on a wagon bed or sleigh. The space occupied by the transformer is approximately 20 ins. x 30 ins., with a height of 36 ins. The coils are insulated in a manner similar to the well known General Electric constant current transformer coils. The conductors are individually well insulated, the insulation between layers is strong and the coil as a unit is subjected to a vacuum drying and compound filling process which effectively prevents the absorption of moisture when the apparatus is used in damp places. After filling the coils are taped and varnished repeatedly until the insulation is more than sufficient to withstand the pressures to which it will be subjected in actual operation. While the rating of the secondary coil is 75 volts and 400 amperes, for temporary operation, especially under the normal conditions of its use in winter time, a very much larger current may be taken from the transformer. For instance, starting with the transformer cold on a winter's day it will be perfectly safe to take 800 amperes for ten or fifteen minutes, and smaller currents can be taken out for correspondingly longer periods. While the transformer is rated at 2200 volts primary, it can be safely operated at voltages up to 2500 and down to 1500. It must be borne in mind, however, that as the primary voltage is reduced below its normal value, the voltage which can be obtained from the secondary will also be reduced.

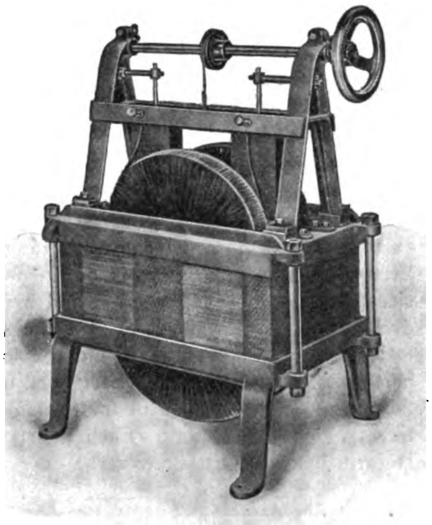


FIG. 8.—TRANSFORMER FOR THAWING OUT PIPES.

HORNSBY-AKROYD OIL ENGINE FOR WIRELESS TELEGRAPH SERVICE.

Fig. 9 herewith shows a 50-h.p. Hornsby-Akroyd safety oil engine, which size and type of engine is to be used by the Navy Department for driving electric generators at the long distance wireless telegraph stations to be operated by the department in Panama and Cuba. A number of smaller units of this type have been operated by the government in the fortifications, lighthouses and wireless telegraph stations on the Atlantic coast. The installations at Key West, San Juan, Guantanamo and Colon have already been completed. The engine consists, as shown, of two standard engines rigidly bolted to a common bed plate. The crank-shaft is in one piece, the cranks being placed alike on the shaft so that both pass the dead center at the same moment. The operation of the engine has been frequently described in these columns so that it is unnecessary to refer to it at length again. It may, however, be mentioned that the engine operates on the four-stroke cycle which consequently gives an impulse in each cylinder at every other revolution, so that in the engine illustrated an impulse will be received every revolution. The fuel used is ordinary kerosene oil, fuel or crude oil. The oil tank is placed under the base of the engine and the fuel is pumped automatically to the vaporizers. The engine is started by means of compressed air and does not at any time require the services of more than one man. When in operation the engine only requires the occasional filling of the lubricators, and the daily replenishing of the oil in the tanks. In the acceptance tests, these engines were said to have shown a fuel consumption of ¾ lb. per actual horse-power per hour. They also carried a 25 per cent overload and the variation in speed with even load was less than 2½ per cent and less than 3 per cent when the load was changed from full to ¼ load. The engines are built by the De La Vergne Machine Company in sizes up to 125 horse-power in single cylinder units.

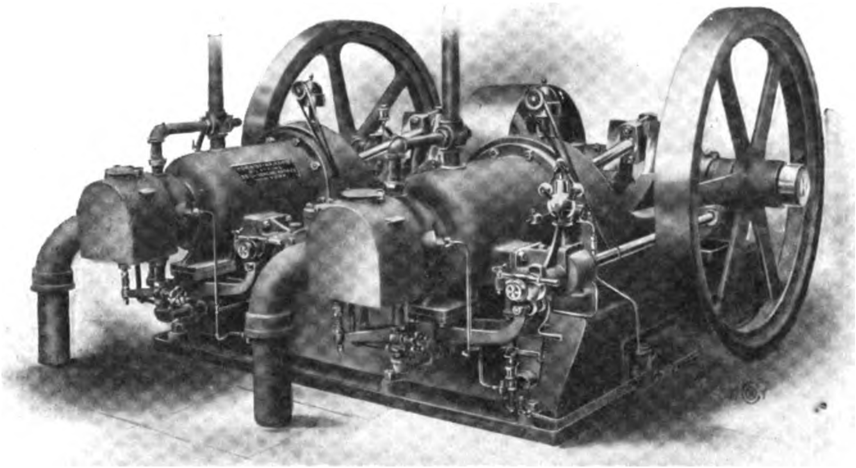


FIG. 9.—HORNSBY-AKROYD OIL ENGINE.

TRANSFORMER FOR PIPE THAWING PURPOSES.

The Pittsburg Transformer Company, Pittsburg, Pa., has brought out the transformer intended for pipe thawing purposes shown by Fig. 10 herewith. The outfit consists of a transformer adapted to operate on any circuit of approximately 1100 or 2200 volts and 60 or 133 cycles. The transformer will deliver a current of 300 amperes continuously or currents up to 600 amperes for periods of half an hour. Mounted on the back of the transformer are a heat indicator and a choke coil. The indicator consists of a section of lead pipe connected in series with the transformer, the temperature which this assumes being a guide as to the heating of the pipe under treatment. The choke coil consists of a few turns of heavy copper bar, with a movable laminated core. When the plunger is pushed entirely into the coil, the secondary of the transformer may be short circuited, but no more than normal current will flow. In operation, the transformer is connected to the primary line in the usual way, the connections on the porcelain terminal block being altered, if necessary, to adapt it to the line voltage. When all the other connections are properly made the plunger is pulled out gradually until the indicator is hot enough. Suitable connectors are provided for attaching the cables leading from the water pipes, and the transformer connections are tagged to avoid error. No. 0 wire or cable is recommended for secondary connections. It is necessary when operating the outfit to protect the transformer with a fuse and to provide a 400-ampere single or double-pole switch. The company has also printed in connection with the outfit circulars for mailing to prospective customers and placards to hang in public places. These are furnished at cost.

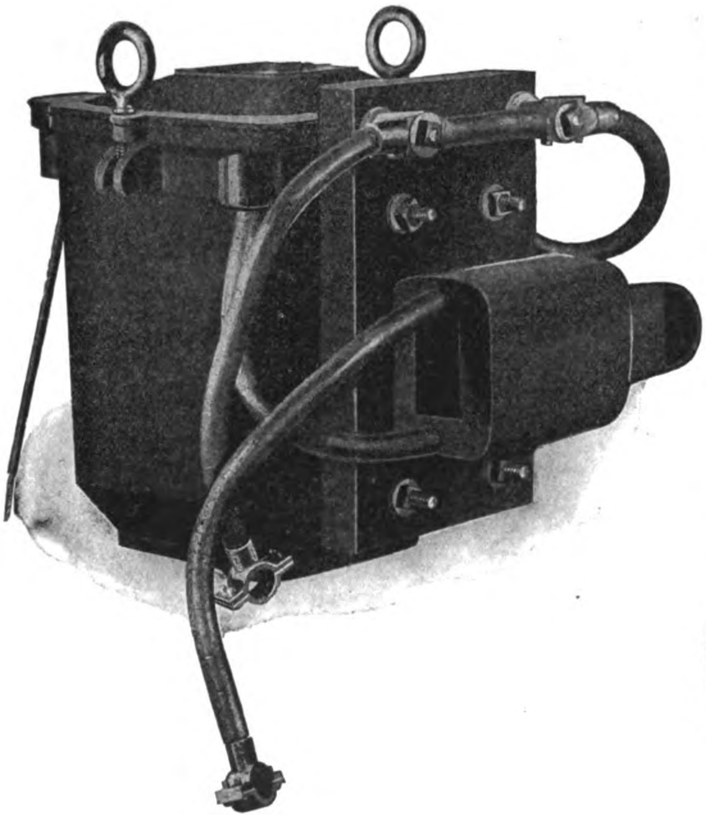
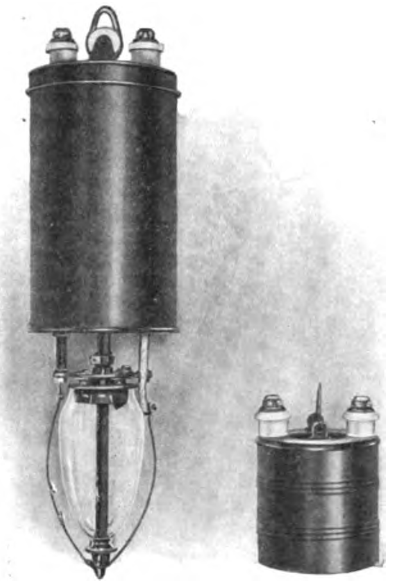


FIG. 10.—TRANSFORMER FOR THAWING PURPOSES.

PHOTO-ENGRAVING AND BLUE-PRINTING ARC LAMP.

Fig. 11 herewith shows an enclosed photo-engraving and blue-printing arc lamp made by the Adams-Bagnall Electric Company, of Cleveland, Ohio. This lamp in construction is very similar to the other types of lamps made by the company and embodies all the well-known features of the A-B lamp. Fig. 12 shows the diagram of connections. The lamps are made for either direct or alternating current and for 110 or 220-volt circuits. The manufacturer recommends the 220-volt, direct-current lamp where conditions are such that it may be used. The violet rays which are most desirable for photoengraving or blue-printing purposes are obtained by operating at this voltage. In order to facilitate the handling of the lamp the external resistance in the direct-current and the reactive-coil in the alternating-current lamps are enclosed in an external case as shown. Both types of lamp are of the solenoid type. Other features are shown in the engravings.



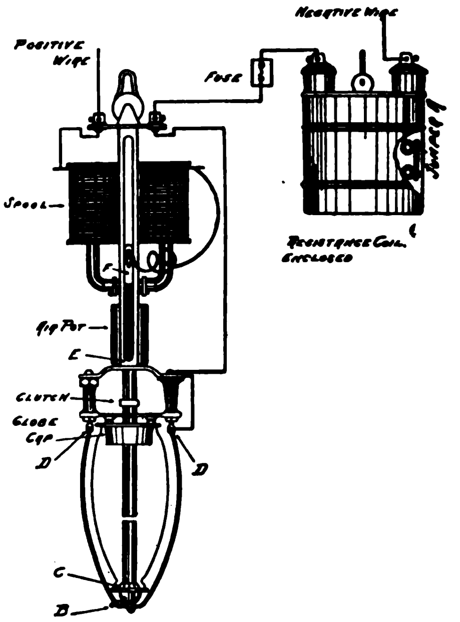


FIG. 11.—BLUE-PRINTING ARC LAMP AND CONNECTIONS.—FIG. 12.

ROBERT COMBINATION VOLT-AMMETER.

The Detroit Electric Company, of Detroit, Mich., has brought out the combined voltmeter and ammeter shown by Fig. 13 herewith. The instrument is of the watch size type with a clearly drawn and equally divided scale. The upper part of the scale is used to indicate amperes and the lower part volts. The instrument is claimed to be dead beat and is convenient for testing batteries and small motors. Each instrument is furnished in a leather case.

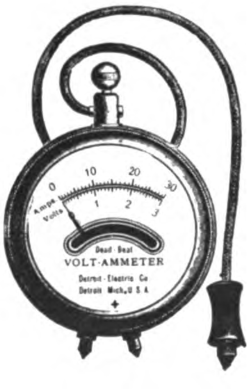


FIG. 13.

NEW BOOKS.

Handbook on Engineering. By Henry C. Tulley. (Fourth Edition.) St. Louis, Mo.: H. C. Tulley & Co. Soft leather; 966 pages, 4¾ ins. x 6½ ins.; 402 illustrations. Price, $3.50.

This edition of Mr. Tulley's book shows evidence of revision, particularly in the refrigeration section and the addition of a chapter of tables. A few of the errors that were in former editions still remain, however. On page 727, for example, the diagram of connections shows the shunt field winding of a reversing motor connected permanently to the brushes, so that the current is reversed in both field winding and armature when the reversing switch is thrown over; it is needless to say that the direction of rotation cannot be reversed with such connections. In the new chapter of tables the reviewer notes several that have been reproduced by photo-engraving from another hand-book without acknowledgment, which is not strictly in accord with the ethics usually observed. In the table of "Properties of Saturated Steam," the total heat above Fahrenheit zero is given instead of the total heat above 32°, rendering this column useless. The tables of boiler and engine dimensions should be very useful; there is also an excellent table of pump dimensions and capacities. A most welcome, though not vitally important, improvement in this edition is the numbering of the illustrations consecutively throughout the entire book. The book has been improved in a number of other minor points also, and after a few more revisions should be substantially above criticism. If the foregoing comments seem at all harsh (which is not intended to be the case), it should be remembered that from ten to fifteen revisions are usually required to make a book of this class free from errors and inaccuracies.

Logarithms for Beginners. By Charles N. Pickworth. New York: D. Van Nostrand Company. Buckram-covered boards; 52 pages, 5 ins. x 7⅛ ins.; 3 tables. Price, 50 cents.

This is an excellent little exposition of the practical application of logarithms. The author starts at the beginning and explains the elementary mathematics on which logarithms are based before taking up the subject proper. Then logarithms and their uses are explained in the simplest of language. Numerous examples are given, together with their answers; for convenience in working the examples, a table of four-place common logarithms and one of four-place anti-logarithms are given. There is also a table of the logarithms of useful numbers, the latter including π and its reciprocal and many sub-multiples. We accordingly recommend the book to anyone who is at all "foggy" on the subject of logarithms.

Mechanical Engineer's Reference Book. (Second Edition.) By H. H. Suplee. Philadelphia: J. B. Lippincott Company. Soft leather; 867 pages, 4 ins. x 6¾ ins.; numerous illustrations and tables. Price, $5; with thumb index, $5.50.

This edition of Mr. Suplee's reference book has been revised to the extent of correcting all the known errors in the first edition and adding twenty pages to the appendix. These additional pages contain tables of Navy standard dimensions of welded flanges for steel pipe, strengths of alloys, composition and uses of alloys, data on flattened strand hoisting rope, shearing strength of rivets, influence of heat on the strength of steel, flow of air through pipes and orifices, classification of locomotives, strength and weight of fly-wheels, friction of water in pipes, and the Crocker-Wheeler system of multi-voltage motor drive. The mechanical work on the book is fully up to the high standard of that which characterized the first edition, and the work has our cordial commendation.

WORLD'S FAIR AWARDS.

It is to be regretted that no official list of the awards by the juries appointed for the purpose of judging the exhibits has yet been issued by the officials of the St. Louis Exposition. We have, however, secured some information from the exhibitors themselves as to the awards received by them, and on this the following list is based.

The awards to the Allis-Chalmers, General Electric and Westinghouse Companies were mentioned on page 607 last month, and therefore will be omitted here.

Electrical Machinery and Apparatus.—Wagner Electric Manufacturing Company received gold medals on its single-phase motors and transformers; also a silver medal on indicating instruments. The jury of awards made thorough tests of the Wagner apparatus, so that the awards were not made on inspection or factory records.

The Electric Controller & Supply Company was awarded a gold medal for its exhibit, which consisted of motor controllers of several types, magnetic friction and stop brakes, cushion-type solenoids, lifting magnets, resistance banks and a working exhibit of variable-speed motor drive for planers.

The Jandus Electric Company exhibited arc lamps and desk and ceiling fan motors, both of which took the highest awards in their respective classes, namely, a gold medal for the arc lamps and a bronze medal for the fan motors.

The Adams-Bagnall Electric Company was awarded a gold medal on its exhibit of A-B enclosed-arc lamps.

Cooper Hewitt Electric Company has been awarded the Grand Prize for the development of the mercury-vapor arc lamp and also received a gold medal for vapor lamps for photo-engraving work.

Batteries and Auxiliaries.—The Electric Storage Battery Company received three awards; a gold medal for storage batteries, controlling and regulating apparatus (booster system); a gold medal for its exhibit of a model central station storage battery outfit, with booster regulation, and a silver medal for switchboards for controlling and regulating storage batteries.

Battery Supplies Company was awarded the bronze medal for its exhibit of primary batteries; this, we understand, was the highest award in this class.

Smaller Electrical Appliances.—Holophane Glass Company received three gold medals and two silver medals for its exhibit of glassware for electric lighting.

The Locke Insulator Manufacturing Company was awarded a gold medal for its well-known glass and porcelain insulators for high potentials and special insulating material.

The D. & W. Fuse Company captured a silver medal (the highest for its class of exhibit) for its well-known product.

Hugo Reisinger feels a pardonable pride in his award of a Grand Prize for "Electra" Nurnberg carbons for arc lamps.

Bogia Regulating Socket Company has been advised that its exhibit will receive a bronze medal.

The Prometheus Electric Company's exhibit of electric heating and cooking apparatus was awarded a silver medal.

The Automatic Electric Company took the Grand Prize for its automatic telephone exchange apparatus and telephone apparatus and appliances in general. The company had an excellent working exhibit which was used by the exposition officials to a considerable extent.

The Leeds & Northrup Co. had an extensive exhibit of resistance-measuring apparatus, potentiometers, galvanometers and curve tracers, on which it was awarded a Grand Prize.

Non-Electrical Instruments.—Keuffel & Esser Company received the Grand Prize for its exhibit of instruments of precision, philosophical instruments, etc., and a gold medal for instruments and equipment for underground surveying.

Steam Engines.—The Ball & Wood Co. had no exhibit in the Exposition proper, but its engine in the Philippine exhibit was awarded by the International Filipino Jury of the Exposition, under the direction of the Secretary of War, a gold medal of the same kind as that given by the Exposition.

Buckeye Engine Company received a gold medal for its well-known engines.

The Fleming engine, built by the Harrisburg Foundry & Machine Works, was awarded a gold medal. The engine exhibited was a tandem compound four-valve, direct connected to a Crocker-Wheeler generator.

The Phoenix Iron Works Company also made an exhibit and received from the International Philippine Jury an award of a gold medal for the compound engine exhibited in the power plant of the Philippine Government Board.

The Hooven, Owens, Rentschler Co., whose exhibit engine was described in the July number of this journal, took a gold medal.

Gas and Oil Engines.—Weber Gas & Gasoline Engine Company was awarded gold medals on its gas and gasoline engines and suction gas producers.

August Mietz received a gold medal and special diploma for his oil engine, known as the Mietz & Weiss engine.

Water Wheels.—The tangential water wheel exhibited in operation by the Abner Doble Co. was awarded the Grand Prize. This wheel, with a 100-kw. Crocker-Wheeler generator to which it was direct connected, constituted one of the units in the power-house of the intramural railway.

Steam Engineering Specialties.—The chain grate stoker of the Green Engineering Company received a gold medal. The exhibit comprised stokers in operation under boilers aggregating 3200 horse-power.

The Worthington turbine condenser outfit (International Steam Pump Company) operated in connection with a Curtis turbine, received the Grand Prize.

Weinland boiler tube cleaners, built by the Lagonda Manufacturing Company, captured a gold medal.

The Cochrane feed-water heaters and purifiers shown in the exhibit of the Philippine Government Board were awarded a gold medal, and the Harrison Safety Boiler Works also received another gold medal on the general exhibit of Cochrane heaters, steam and oil separators and Sorge-Cochrane systems of feed-water heating and purifying.

The Ashton Valve Company received a gold medal for its pop safety valves and steam gauges, exhibited in Machinery Hall.

Other Machinery.—C. W. Hunt Co. was especially fortunate in the matter of awards. Its industrial railway system received a gold medal and the Hunt electric storage battery locomotive was awarded a silver medal, which was the highest award in this class of locomotives.

Robins Conveying Belt Company received a Grand Prize for its coal conveyor equipped with distributing tripper and shown in Machinery Hall, and a gold medal for the conveyor installed in the U. S. Geological Survey exhibit.

Richardson Scale Company was awarded a gold medal for its automatic weighing machinery, which was exhibited in conjunction with the Robins conveyor system just mentioned.

E. W. Bliss Co., whose sheet-metal-working machinery is used by many manufacturers of electrical apparatus, was awarded a Grand Prize for "superiority of workmanship, smoothness of action, ingenuity of design and high quality of product" as embodied in its sheet-metal-working machines. The company took a gold medal on its arsenal machinery.

Niles-Bement-Pond Co. received a Grand Prize on the machine tools of its manufacture.

The Pratt & Whitney Co. carried off the Grand Prize and a gold medal for machine tool equipment for arsenals.

Belting.—The Shultz Belting Company received a gold medal on its "Sable" rawhide belting, belt cement, etc. We understand that this was the highest award in the belting class.

Fire Protection.—"Kilfyre," manufactured by the Monarch Fire Appliance Company, took the highest award in its class; this was a bronze medal.

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CONVENTION OF DISTRICT MANAGERS OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.

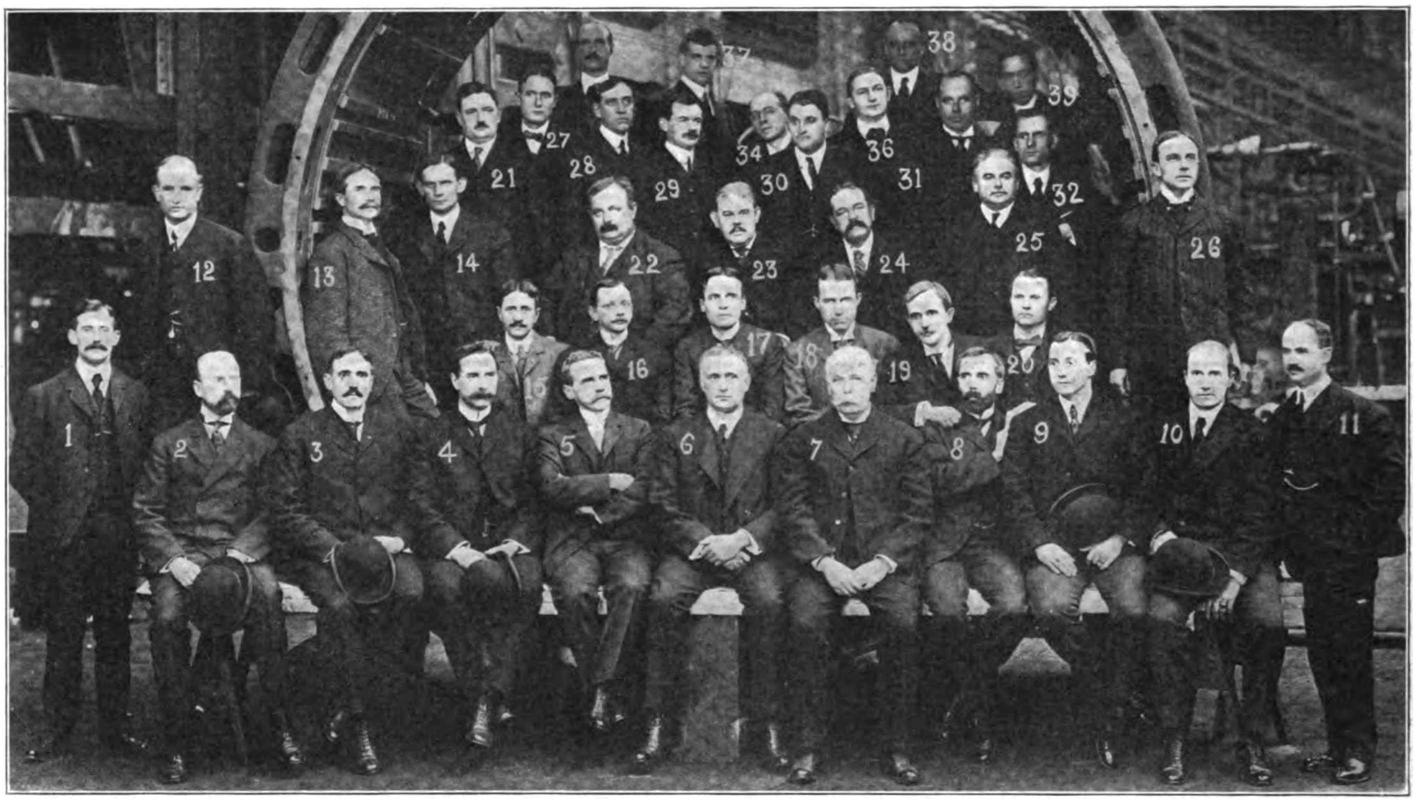
During the week ending November 19 the district managers of the Westinghouse Electric & Manufacturing Company gathered at the works at East Pittsburg and discussed plans and methods for the coming year. These conventions are annual occurrences and are productive of much good, bringing together men from all parts of the United States whose experiences are the natural outgrowth of conditions under which they labor.

Those attending the convention were Messrs. Calvert Townley, General Agent, New York; G. Pantaleoni, General Southwestern Manager, St. Louis; R. L. Warner, New England Agent, Boston; E. W. T. Gray, New York; D. E. Manson, Boston; W. S. Heger, San Francisco; F. B. H. Paine, Manager of Export Office, New York; C. W. Underwood, Buffalo; C. F. Medbury, Detroit; G. R. Dusinberre, Cleveland; W. F. Fowler, Baltimore; C. A. Bragg, Philadelphia; M. P. Randolph, Seattle, Wash.; S. J. Keese, Los Angeles, Cal.; P. N. Jones, Pittsburg; D. E. Webster, St. Louis; T. P. Gaylord, Chicago; L. M. Cargo, Salt Lake City; J. R. Gordon, Atlanta, and T. J. McGill, Minneapolis.

Throughout the convention there was evident a feeling of optimism regarding the business situation and the prospects of continued prosperity throughout the country. Mr. Heger stated that the outlook on the Pacific Coast was never better, work being plentiful and money easy. "Mining projects in California are flourishing," he said, "and they appear to have plenty of money behind them. This insures large installations of Westinghouse electrical machinery." Mr. Cargo said that the election of Roosevelt had given a decided impetus to mining development in Utah, Arizona, Nevada and New Mexico; capital which prior to that had been timid being induced to pour money liberally into dormant investments.

Mr. Gordon said: "The South will soon have the greatest boom of its history. For the past two years the cotton crop, the barometer of Southern prosperity, has been phenomenal. Business conditions reveal a greater stability and the increase of manufacturing in the South is extraordinary. Abundant water power easily available will prove an enormous boon and a producer of business for Pittsburg. Mr. Bragg said that the outlook for general industrial activity was never brighter; while there has been plenty of capital during the past year, timidity over unsettled political conditions prevented its investment. Lack of confidence has disappeared and hopeful buoyancy is observable everywhere.

Mr. Gray said that New York suffered severely the past year because of building strikes, but that since these subsided business has been good there. He thought it a foregone conclusion that business will be even better, as "cheap money is abundant and there is no lack of financial support for any legitimate enterprise." Mr. Paine,



WESTINGHOUSE REPRESENTATIVES AT THE DISTRICT MANAGERS' CONVENTION.

1. E. W. T. Gray; 2. D. E. Manson; 3. C. W. Register; 4. C. B. Humphrey; 5. C. A. Terry; 6. F. H. Taylor; 7. W. S. Heger; 8. F. B. H. Payne; 9. G. B. Griffin; 10. C. W. Underwood; 11. C. F. Medbury; 12. J. R. Gordon; 13. C. Townley; 14. M. P. Randolph; 15. J. C. Bennett; 16. S. L. Nicholson; 17. L. A. Osborn; 18. R. L. Warner; 19. G. B. Dusinberre; 20. J. E. Johnston; 21. P. N. Jones; 22. C. S. Cook; 23. W. M. McFarland; 24. C. A. Bragg; 25. S. J. Keese; 26. W. F. Fowler; 27. S. E. Webster; 28. S. H. Anderson; 29. N. S. Braden; 30. F. L. Shepard; 31. W. Cary; 32. C. F. Scott; 33. L. M. Cargo; 34. G. Pantaleoni; 36 F. F. Rohrer; 37. T. J. McGill; 38. J. W. Sterns; 39. A. Goodby.

manager of the export department, said that the outlook for foreign business has never been more promising for American manufacturers because never before were Europeans more alive to the superiority of American manufacturing methods.

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OPPORTUNITY FOR SALE OF ELECTRICAL APPARATUS ABROAD.

Mr. O. L. Remington, now in this country in the interests of William McLean & Co., Melbourne, Australia, will be in New York, at the Astor House, for a few days beginning on or about December 21, and desires to confer with manufacturers who wish to establish business connections in Australia. We understand that his house already represents the Bullock and Wagner Companies, as well as some other representative builders of electrical apparatus, and desires to increase its representation of American manufacturers.

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COMPARATIVE GAS AND STEAM PLANT DATA.

A prominent engineer of the Power & Mining Machinery Company gives the following interesting particulars concerning the economies of gas generating plants as compared with steam plants:

The yearly records of 11 electric power stations, each serving a population of 5000 or less, and of 45 stations, each serving 5000 or more, show:

The average brake horse-power developed, 1235; the average coal consumption per b.h.p. hour, 5.5 lbs.; the average cost of coal per ton, $4.30.

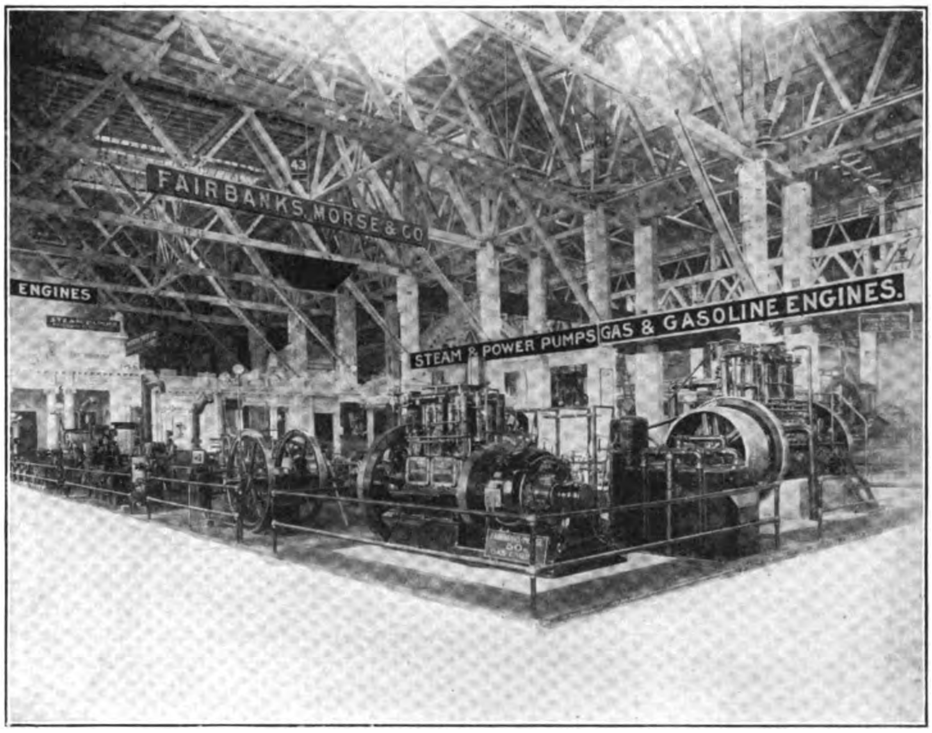
Cost of fuel in steam plant (operating 10 hours per day): 33.96 tons coal at $4.30 a ton, $146.02.

Cost of fuel with gas engines and producers: 7.72 tons coal at $4.30 a ton, $33.19.

Saving per day, $112.83; annual saving (365 days, at $112.83), $41,182.95.

EXHIBIT OF FAIRBANKS, MORSE & CO. AT ST. LOUIS.

The accompanying illustration shows a part of the exhibit made by Fairbanks, Morse & Co., in Machinery Palace at the St. Louis Exposition. The exhibit has been made especially attractive and complete, various machines being shown in operation. A 150-h.p., vertical gas engine is belt connected to a 75-kw. dynamo, and a 50-h.p. vertical engine is direct connected to a 30-kw. dynamo. Both of these machines generate current at 110 volts which is delivered to the switchboard shown in the engraving. A motor-generator set also made by the company is controlled from the switchboard and is used to convert 110-volt current to 220-volt current for power purposes. The 110-volt current was used for lighting purposes and the 220-volt current was used to drive a direct-connected motor-driven duplex double-acting water pump and a direct-connected geared hoist. Other small motors were shown in operation. The company also had on exhibition its full line of generators, and a small direct-connected generator of 6 horse-power. This latter set was shown in operation, the engine using kerosene oil and a lighting circuit supplying the load for the generator. The full line of engines and generators made by the company ranges from 2 horse-power to 150 horse-power inclusive. The exhibit was brilliantly lighted by numerous clusters and arc lights together with a double-faced electric sign. A second electric sign over one of the adjacent spaces in Machinery Hall was also supplied with current from the exhibit. The regulation of both of the large engines driving generators was especially good, the variation in the speed of the electric generators between no load and full load being a little over 1 per cent.



FAIRBANKS, MORSE & CO.'S EXHIBIT AT ST. LOUIS.

A HEROIC TEST.

Three Westinghouse 62½-kw. engine-type generators which have been in service in the basement of the New England Building, in Cleveland, Ohio, were recently subjected to a test which shows up Westinghouse construction in a very good light. A fire occurred in the basement where the generators were installed and completely burned away the insulation on the outside of the field coils; the fire department played upon these machines with six lines of hose for an hour. Within one hour from the time the water was turned off the machines, one of them was in operation and carrying its full rated load. The second machine was put in operation later, and carried its full rated load, and at the present time two of these machines are operating under the load normally carried by all three of them. The fire-proof insulation of the field coils withstood the fire perfectly even though the outer protecting coverings were entirely consumed, and the heat was so intense as to burn and blister the finish on the frames. Electrical machinery as usually constructed is scarcely expected to stand a fire and water test, but it appears that such a guarantee might have been made on these generators.

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OBITUARY.

FRANK B. BRISTOL, first vice-president of the Bristol Manufacturing Company, was killed on November 21 in a collision between an automobile in which he was riding and a train of the N. Y., N. H. & Hartford Railroad, at Waterbury, Conn. Mr. Bristol's automobile was approaching a railroad crossing at too high a speed to be stopped before reaching the tracks, and in trying to spurt across before the train arrived at the crossing the collision occurred.

WILLIAM H. LAWRENCE, a well-known consulting engineer of Baltimore, Md., died on November 5 at his home in Baltimore. Mr. Lawrence was one of the pioneers in the electrical industry in Baltimore and vicinity; for several years he was identified with the firm of Davis & Watts, which subsequently became the Viaduct Manufacturing Company, and for the past few years he restricted his work entirely to consulting engineering for that company.

DR. THOMAS M. DROWN, president of Lehigh University, died at South Bethlehem, Pa., on November 16. Dr. Drown was 62 years old, and had been president of the University since 1895. He was a graduate of the University of Pennsylvania and took additional courses at Yale and Harvard in chemistry. In 1874 he became professor of chemistry at Lafayette College, Easton, Pa., and in 1885 was appointed to the same chair at the Massachusetts Institute of Technology, where he remained until he accepted the presidency of Lehigh. He was a prominent and useful member of several technical societies.

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PERSONAL.

MR. THOS. L. TOWNSEND, who has been for the past two years general sales manager of Vallee Brothers Company, Philadelphia, has severed his connection with that company.

MR. DWIGHT WALLICK has resigned the position of electrician to the York Telephone Company, York, Pa., and accepted a similar one with with the Pennsylvania Telephone Company.

MR. ALLAN POLLOK has again been appointed manager of the San Francisco Gas & Electric Company, which position has been vacant since the resignation, several months ago, of Mr. J. F. Lawless.

MR. CHARLES F. BARTH, foreman of the Westinghouse Machine Company's works, has resigned that position to accept the place of foreman of the steam turbine department of the Allis-Chalmers Company.

MR. O. R. BOLMS, who has been a member of the New York Telephone Company's staff in the cable department for the past two years, has severed his connection with that company and accepted an important position with the New York & New Jersey Telephone Company.

MR. R. C. WRIGHT, who has for several years been in charge of the design of special tools and fixtures used in the manufacture of steam turbines at the Westinghouse Machine Company's shops, has resigned his position there in order to accept a similar one with the Allis-Chalmers Company, Milwaukee, Wis.

MR. EDWARD JAMES has been engaged by the Pittsburg Gage & Supply Company to travel in its interests in the South and West. Mr. James was for many years in charge of the filter department of the Burt Manufacturing Company, and will devote his attention now to the White Star oil filtering apparatus of the Pittsburg company.

MR. NORMAN K. DEVENDORF, chief operator of the Hudson River Water Power Company and formerly superintendent of this company's power house at Mechanicsville, has resigned his position with the Hudson River Company to accept a responsible post with the St. Lawrence River Power Company, Massena, N. Y. He will have charge of the company's transmission lines.

MR. CHARLES LANG, formerly on the staff of the Wheeler Condenser & Engineering Company, has accepted a position on the sales staff of the A. D. Granger Company. Mr. Lang will give particular attention to the pump and condenser departments, and will have his headquarters at the New York office of the Granger Company. This company recently acquired the agency for the Barr Pump Company, of Philadelphia.

CAPTAIN E. A. SAWTELLE, who has been identified with Westinghouse interests for several years, in both this country and England, is on the way to New York as we go to press. Capt. Sawtelle is to be married early in this month to Miss Julia Worthington, granddaughter of Mr. Henry Worthington of pumping machinery fame. Capt. Sawtelle is said to be one of the most popular Americans who has ever gone to England in connection with engineering work.

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TRADE PUBLICATIONS.

GAS FOR POWER AND FUEL. R. D. Wood & Co., Philadelphia.—An octavo pamphlet containing illustrations and descriptions of gas producers built by this firm.

H-W CROSS-HEAD-PIN OILER. The Lunkenheimer Company, Cincinnati, Ohio.—A vest-pocket pamphlet containing a brief illustrated description of the oiler mentioned.

PRODUCER GAS. Wile Power Gas Company, Rochester, N. Y.—This is Section 1 of Catalogue 'A," devoted to producer gas for power and fuel, and relates to the cost and uses of producer gas,

THE POWER OF THE NEW YORK SUBWAY. Allis-Chalmers Company.—This is a handsome brochure containing some general information concerning the new subway and specific information as to the machinery supplied to the Interborough Company by the Allis-Chalmers Company.

AIR BLAST TRANSFORMERS. General Electric Company.—Bulletin No. 4391, superseding No. 4224 and containing an illustrated description of the well-known G. E. air-blast transformer. This edition includes the two-phase and three-phase transformers which have recently been developed by the company.

TOLL BOARDS. Stromberg-Carlson Telephone Mfg. Company, Rochester, N. Y., and Chicago, Ill.—Bulletin No. 12, devoted to telephone toll-boards and containing well-illustrated descriptions of the boards and their component parts. The bulletin is handsomely executed and the descriptive matter is far from perfunctory.

SOLID KNEE MILLING MACHINES. The Garvin Machine Company, New York.—A well-executed pamphlet of vest-pocket size, containing a fully-illustrated description of the latest form of extended knee with which Garvin millers are equipped. The knee is entirely closed, this construction being said to prevent all spring and chatter.

ELECTRICAL MEASURING INSTRUMENTS. The Leeds & Northrup Company, Philadelphia. —A book of standard catalogue size devoted to the resistance-measuring apparatus, potentiometers, galvanometers, curve-tracers, etc., exhibited at the St. Louis Exposition by the Leeds & Northrup Company. The book is fully illustrated and the descriptive matter is full and clear.

DISCOUNT SHEET. General Incandescent Arc Light Company, New York.—This is a discount sheet applying to all of the catalogues of the G. I. Company, but it differs from any others that we have seen in that the sections relating to the several catalogues are tinted to correspond to the color of the catalogue; the section applying to the panel-board catalogue, for example, is tinted blue, to match the color of that catalogue.

STANDARD ENCLOSED FUSES. Chase-Shawmut Company, Newburyport, Mass.—This is Bulletin No. 28, containing illustrations and price-lists of a very complete line of enclosed fuses, standard bases, and fuse contact clips. The company has adjusted its entire line of fuses and holders to conform to the National Underwriters' requirements for interchangeability of products from different manufacturers, and now has a full stock of interchangeable enclosed fuses and fittings ready for market.

ELECTRIC LIGHTING SPECIALTIES. Benjamin Electric Mfg. Company, New York.—Catalogue B-15, relating to wireless incandescent lamp-socket clusters for all classes of service. These excellent devices eliminate the use of wire within the cluster itself, the base being provided with terminals for connection to the circuit in much the same way that a ceiling rosette is connected up; all internal connections between the sockets and the terminals are made in the construction of the cluster.

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BUSINESS NEWS.

BOSSERT ELECTRICAL CONSTRUCTION COMPANY, Utica, N. Y., is supplying the switchboards and panelboards for the new government laboratory at Manila, P. I.

COMMERCIAL ELECTRICAL SUPPLY COMPANY, St. Louis, has arranged to handle the telephone and switchboard business of the Vought-Berger Company in the South and West. All southwestern business will be handled through the St. Louis agency.

THE PLATT IRON WORKS, Dayton, Ohio, has bought the plant, good-will and existing contracts and orders of the Stillwell-Bierce & Smith-Vaile Company, builder of the well-known Victor turbines and Smith-Vaile pumping machinery, feed-water heaters, etc.

THE WESTERN DISPLAY COMPANY, of St. Paul, Minn., is calling attention to its "Reflectric" advertising signs. These signs are appropriate for every class of business advertising, and the manufacturers are sending out some interesting printed matter concerning them.

THE TRUMBULL ELECTRIC MFG. COMPANY, Plainville, Conn., has added to its well-known line of electrical specialties the manufacture of switchboards and panel-boards. The company has also added to its factory facilities and now is in position to handle all orders with extreme promptness.

ALLIS-CHALMERS COMPANY'S New England offices, heretofore in the Board of Trade Building, Boston, and those of the Bullock Company in the *Journal* Building have been consolidated and removed to the State Mutual Building, No. 50 Congress Street. George H. Berg is in charge of the consolidated offices.

THE W. R. EVANS ENGINEERING & CONSTRUCTION COMPANY, Cincinnati, has been organized for the purpose of doing an engineering and general contracting business, building, promoting, financing and engineering electric light and railway propositions and similar enterprises. Mr. W. R. Evans is the president of the new company.

THE BALL ENGINE COMPANY, Erie, Pa., recently closed a contract with the New York & Pennsylvania Company, Johnstown, Pa., for two 1000-horse-power vertical cross-compound Corliss engines for direct connection to electric generators. The company's business in smaller engines of both the Corliss and shaft-governor types continues brisk.

AMERICAN STEEL & WIRE COMPANY has thus far supplied to the Interborough Rapid Transit Company for use in connection with the subway system over 267,000 feet of paper-insulated and lead-encased feeder cable of 2,000,000 circular mils cross-section. This cable is made up of 91 wires, and the diameter over the lead sheathing is about 2¼ inches. The quantity of copper used in 267,000 feet is about 900 tons.

THE FORD ELECTRIC & MFG. COMPANY, St. Louis, Mo., recently bought the entire plant, good-will and outstanding business of the St. Louis branch of the Rossiter-MacGovern Electrical Company and has reorganized the plant so that its repair shops now rank among the largest and best-equipped in the Southwest. The transportation facilities are also unusually good, a spur from the tracks of the Terminal Railroad Association extending directly to the works.

ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, reports among recent contracts for "Chloride" accumulators, two three-wire batteries for the Union Electric Light & Power Company, St. Louis; a three-wire battery and an exciter battery for the Boston Edison Company; a three-wire battery for the Rochester (N. Y.) Railway & Light Company; an exciter battery for the Interborough Rapid Transit Company, New York, and a lighting and power battery for the New York Hall of Records (sold through the Chas. L. Eidlitz Company).

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has sold to J. E. Henry & Sons, Lincoln, N. H., two large induction motors for use in their pulp mill. The larger motor is a Type F machine rated at 600 horse-power and will be supplied with three-phase currents at 400 volts and 25 cycles. The motor will be direct-connected to two pulp grinders and will run at a speed of 230 r.p.m. The smaller motor is a Type C constant speed machine rated at 300 horse-power. It will also be connected to a pulp grinder and will run at a speed of 205 r.p.m. These motors are ordered in addition to a large number of machines which have been purchased from the Westinghouse Company for this paper mill. Twenty-four induction motors and four 350-kw. alternators, with exciters, switchboards, transformers and detail apparatus have been ordered, and the greater part of these have been delivered.

SHEPHERD ENGINEERING COMPANY, Franklin, Pa., is evidently not suffering from the hard times preceding the recent election. Among their most recent installations are a 600-horse-power, four-valve cross-compound engine to the Eberhard Faber Pencil Company, of Brooklyn, N. Y.; two 250-horse-power engines, each direct-connected to two generators, installed in the Russia Building, Boston, Mass., and one engine direct-connected to a Crocker-Wheeler generator, at Fort Andrews, Boston Harbor. Among recent orders booked are two engines for Brandon Hall, Beacon Hill, Boston, Mass.; three engines for the new office building of the Columbus Savings & Trust Company, Columbus, Ohio; two engines to the Arbuckle-Ryan Company, Toledo, Ohio, and one to the Joyce-Cridland Company, Dayton, Ohio. The Shepherd engine is a highly developed example of the high-speed automatic type, combining strength and rigidity with simplicity of design and economy in operation.

CENTRAL STATION NEWS

Readers are cordially invited to contribute to this department items of news relating to plants in their vicinity.

ALABAMA.

SELMA.—G. H. Rettew, until recently superintendent of the Selma Lighting Company, has been transferred to the home office of the company at Philadelphia. He has been succeeded here by Mr. R. L. Ellis, of Biloxi, Miss.

OPELIKA.—Mr. S. H. Browne, who has been connected with the electric light plant in this city for the past several years, has accepted the position of superintendent of the municipal electric light plant and water works at Union Springs, this state.

ARIZONA.

PHOENIX.—The Green River Power, Land & Irrigation Company has been incorporated by P. W. Barclay and George C. Plummer. The company is capitalized at $500,000; its principal place of business will be at Phoenix, and it is proposed to engage in irrigation, the construction of canals and dams and the construction and operation of electric power plants.

ARKANSAS.

SEARCY.—The contract for the construction of the municipal electric light plant for this town has been let to the Black Hawk Electric Company, of Davenport, Iowa, for $19,105.

BRINKLEY.—The Farrell Light & Heat Company has filed articles of incorporation. The company purposes to manufacture and supply heat, light and water for the town, its citizens and corporations. The capital stock is $50,000, and the incorporators are J. J. Farrell, president; H. W. Boyle, vice-president; W. S. Kilpatrick, secretary; Patrick Farrell and Thomas J. Doyle.

CALIFORNIA.

RIVERSIDE.—The Oxhard Light & Water Company has purchased a tract of land on which to erect a new lighting plant.

STOCKTON.—James Kelly is now chief engineer of the plant of the Stockton Gas & Electric Company, and B. F. Wellington, Jr., assistant superintendent.

SAN JOSE.—The Tuolumne Electric Company has been incorporated with a capital stock of $200,000 by R. W. Hersey, C. W. Quilty, J. J. Dunne and others.

UKIAH.—The Ukiah Redwood Lumber Company, which was recently incorporated with a capital of $50,000, is making arrangements to install an electric light plant.

AZUSA.—The city has purchased the lighting plant of the Azusa Electric Light & Power Company for $2300, and the plant will hereafter be operated as a municipal plant.

ALAMEDA.—The Trustees have taken steps toward securing new machinery to be installed in the municipal electric light plant, including a turbo-generator set and an engine and dynamo.

RIALTO.—A committee of Rialto business men is reported to have asked the San Bernardino Gas & Electric Company, of San Bernardino, to extend lines to Rialto for lighting and power purposes.

GUERNEVILLE.—The Guerneville Light Company has been incorporated by W. P. Turner, O. O. Cobb and W. A. Turner, with a capital of $25,000, to construct and maintain a lighting plant and water works in this town.

OROVILLE.—Col. P. Henshaw, of Chico, has petitioned for a franchise to erect poles and string wires for the purpose of transmitting electricity for light and power purposes in Butte County. It is probable that lines will be run to Chico and Marysville.

OROVILLE.—The Tehama County Water Company has filed articles of incorporation stating the capital stock to be $1,500,000. B. A. and S. M. Steiffer are among the incorporators; the company was organized for the purpose of manufacturing and distributing electricity.

SAN LEANDRO.—The Mt. Diablo Light & Power Company has been incorporated, to furnish electric light, heat and power. The company's principal place of business will be at San Leandro; capital, $50,000. Directors: J. W. Burge, of Haywards; C. A. Jeffery, Oakland, and G. J. Clark, of San Leandro.

QUINCY.—A company has been incorporated known as the Pacific Power Company, to operate in Plumas County. It is proposed to transmit power to San Francisco, a distance of 200 miles; capital, $1,000,000. The business office of the company will be at Minneapolis, Minn. George E. Maxwell, president; George P. Darling, secretary.

VISALIA.—The Mt. Whitney Power Company is said to have purchased the rights and interests of the Bursell & Henley Power Company, on Middle Tule River, and also the stock of the Globe Light & Power Company. As soon as the right of way is finally settled the Mt. Whitney Company will install a power plant on the Middle Tule. C. H. Holley, superintendent and chief engineer, Visalia.

FORTUNA.—The Fortuna Lighting Company has been incorporated with a capital of $60,000. Directors: L. M. Hancock, Denver Sevier and D. S. Newell. The new company is the successor to the plant of the Humboldt Milling Company of Fortuna. The new company also acquires the franchise of the Milling Company for the extension of electric light and power lines into the adjacent townships.

EUREKA.—The North Mountain Power Company has about completed its power line from the plant on the Trinity River to Eureka and expects to begin supplying electricity by the first of the year. Most of the machinery has been installed and work on the sub-station here is being pushed as rapidly as possible. The building will be of sheet iron, 135 feet long by 30 feet wide and the side walls will be 26 feet high.

LOS ANGELES.—The Edison Electric Company of Los Angeles is making preparations to commence active work on its Kern River power plant the first of the year. Power house No. 2, in Santa Ana Canyon northeast of San Bernardino, has been completed, and the company expects to keep a large force of men at work at the head of the canyon preparing the site for the erection of a plant on the Clark place.

MAGALIA.—The Valley Counties Power Company, which is controlled by the California Gas & Electric Corporation, of San Francisco, has recently completed the installation of an additional dynamo with a capacity of 6000 horsepower at the De Sabla powerhouse, Centerville, eleven miles from here. This doubles the capacity of the plant, there being already in operation two machines with a combined capacity of 6000 horsepower. The water power used at this plant is secured from Butte Creek and is brought to the power house by means of a pipe line over half a mile long. The installation of the new dynamo necessitated laying another pipe line 2600 feet long and 30 inches in diameter.

TRUCKEE.—The final contracts between the Truckee River General Electric Company and the thirty-two mining companies comprising the Comstock Pumping Association have been closed. The ten-year contracts call for the delivery of electric power for draining the Comstock mines, lighting, hoisting, etc., the maximum amount being 5000 horsepower. In order to fill these contracts for additional power the Truckee River Company has prepared plans for a second electric generating plant, having double the capacity of the old one, and a new pole line thirty-two miles in length. Water will be diverted from the Truckee River and conducted to the extreme eastern end of the company's hydraulic system, where it will be utilized by water wheels operating under a head of 141 feet. If the maximum 5000 horsepower is used the rate is to be $4.50 per horsepower per month, with proportionate rates for lesser amounts. This is based on meter readings, and will save the mining companies a considerable amount of money compared with the contracts formerly existing. The pumping association will spend about $80,000 for additional 800-h.p. electric pumps, which are to be installed in the Ward shaft. This machinery will be delivered in nine months. The pumps will lift 3200 gallons per minute 1550 feet from the 3100-foot level to the Sutro tunnel. The machinery contracts will be closed at once.

COLORADO.

CANON CITY.—The Colorado Electric Power Company recently closed a contract with the Arkansas Valley Electric Company, of Florence, to furnish power for lighting and other purposes in that city, and has begun the construction of the necessary transmission lines. The new line will be run from South Canon through Chandler and Rockvale to Florence, a distance of nine miles. The work is being rushed with all possible speed and it is expected that the line will be in operation early in January. The Power Company has also secured a contract from the Victor Fuel Company, under the terms of which it will furnish power for the latter company's new Radiant coal mine eight miles south of Florence, and plans are maturing for extending the wires to that camp from the vicinity of Rockvale. The Colorado Electric Power Company already operates a successful transmission line to Cripple Creek.

ROCKWOOD.—B. F. Schmid, general manager of the Animas Canal, Reservoir, Power & Investment Company, states that the contract work on its transmission system is being pushed as fast as possible, and it is hoped that it will be in operation by May 1 next. The company expects eventually to be able to supply current within a radius of one hundred miles from Rockwood. The main power plant will be situated near this city, with an auxiliary station about nine miles south of here. The two stations will develop ultimately 60,000 horsepower. The project includes the building of a large reservoir with an ultimate capacity of 4,500,000,000 cubic feet, which will be supplied from Cascade Creek and Animas River by means of two ditches. From the reservoir the water will be carried by a four-mile flume to the bluffs of the Animas River, where a fall of one thousand feet will be obtained. It is estimated that the cost of the work will approximate $2,000,000. The equipment includes 2200-kw. generators and the current will be distributed through step-down transformers. It is stated that sufficient contracts for power have been secured from mining corporations and others to insure the success of the undertaking.

CONNECTICUT.

CANAAN.—The Berkshire Power Company has commenced work on the erection of a dam and electric power house on the Housatonic River near the toll bridge in this city. Upon the completion of this plant it is understood that the Norfolk Electric Light & Power Company whose stock was recently transferred to new stockholders, will be merged with the Berkshire Power Company, as both companies are now controlled by virtually the same people.

DELAWARE.

NEW CASTLE.—The Delaware Water & Improvement Company, of which James M. Seabury, of Philadelphia, is president, has been granted a 25-year franchise for the operation of electric light and water plants in this city. It is understood that the new concern will supplant the New Castle Water Works Company.

WILMINGTON.—The Interstate Power Company has succeeded the Wilmington City Electric Company. J. A. Rigg continues as president; Remie Remont is vice-president; S. S. Hogg, general manager, and D. L. Ott, assistant superintendent. Under its city contract the company supplies 315 2000-c.p. arc lights and 507 16-c.p. incandescent lights.

FLORIDA.

STARKE.—The Starke Electric Light & Water Company is equipping its plants with a storage battery system which will be used to run the lights in case of any trouble with the machinery at any time.

LAKE CITY.—Robert W. Adams, president of the Lake City Electric & Water Company, died recently from the effects of a stroke of paralysis after a very short illness. Mr. Adams, although a young man, was also president of the State Exchange Bank and held other important interests in this city.

WINTER PARK.—A charter has been granted to the Winter Park Electric & Fuel Company, with a capital of $25,000, to construct and operate electric plants for the generation and sale of electricity for lighting and other purposes. J. M. Cheney, H. W. Greetham and H. H. Yowell are among the incorporators.

GEORGIA.

HARTWELL.—The city has advertised for bids for an electric light plant to cost $15,000.

EATONTON.—The Putnam Mills & Power Company has been incorporated with a capital stock of $500,000. Among the directors are O. B. Nisbat and W. B. Floyd.

GREENSBORO.—The citizens have voted unanimously to issue bonds for the establishment of an electric light plant, and the new system will be installed at an early date.

NEWMAN.—It is understood that the city has decided to purchase the plant of the Newman Light & Power Company, the people having recently voted for an issue of bonds for this purpose.

QUITMAN.—For the third time the city has found it necessary to increase the capacity of its plant. With the new dynamo just installed the city is now prepared to furnish power for about 8000 lights.

BUFORD.—The election held here recently on the question of a bond issue resulted in a vote for the bonds by a large majority. The city will at once issue bonds to the amount of $2,000, part of which will be used to establish an electric light plant and water works system.

CAMILLA.—At the recent election held for the purpose the citizens voted for an issue of bonds to the amount of $20,000, the proceeds to be disbursed as follows: $7000 for the erection of an electric light plant to be owned and operated by the city, $11,000 for establishing a system of water works, and $2000 to pay off the present bonded indebtedness of the town.

MONTICELLO.—The town has recently made a contract for light with Messrs. C. L. Thompson and John M. Henry, Jr., who will immediately install an electric light plant. Under the terms of the contract the city will be supplied with forty 32-c.p. incandescent lights and five arc lights for $125.00. Messrs. Thompson & Henry also agree to make the necessary repairs and to furnish fuel and power for the water works at $150.00 a month additional.

ATLANTA.—The large power plant of the Atlanta Water & Electric Company, which has been in the course of construction for some time, has been completed at a cost of $1,350,000. The plant is operated by water power derived from Bull Sluice Shoals, near this city, and furnishes electric power to the Georgia Railway & Electric Company for operating its street railways, lighting and power plants. The equipment includes seven pairs of 2400-h.p. turbines direct-connected to 1500-kw. generators and two single turbines of 250 horse-power each.

ILLINOIS.

ANNA.—Owing to the destruction of the city's plant by fire recently, the town is without light.

MACKINAW.—The electric light plant, owned by S. A. Thompson, has been destroyed by fire.

DELEVAN.—The city recently lost its electric light plant by fire, which has left the city without light.

GIFFORD.—Reports state that William Wooldridge and W. H. Piper contemplate establishing an electric light plant here.

GENESEO.—The directors of the Geneseo Electric Light Company have voted to issue $8500 bonds to be used in installing new machinery and boilers in its plant.

GRANITE CITY.—The Granite City Light & Fuel Company has filed articles of incorporation, placing its capital stock at $200,000. W. F. Niedringhouse is one of the directors.

PAXTON.—Reports are to the effect that a movement is on foot here for the organization of a company to purchase the plant and property of the Paxton Electric & Power Company.

CHESTER.—Harvey Neville and A. G. Neuling, with others, have filed articles of incorporation for a company with a capital of $10,000. The company purposes establishing electric light and cold storage plants.

MORRISON.—Articles of incorporation have been filed by George A. Whitcomb, Ed. A. Smith and Harvey S. Green for the Rock River Hydro-Electric Milling & Power Company, Inc., with a capital stock of $50,000.

SPRING VALLEY.—The Spring Valley Lighting & Power Company has been granted a charter to construct a light, heat and power plant. The company's capital is $100,000, and the incorporators are John McFadden, R. Reichardt and H. E. Brown.

MANSFIELD.—Articles of incorporation have been filed for the Mansfield Electric Company by Messrs. E. E. Saylor, R. E. Howe and C. W. Fiske. The company's capital is fixed at $10,000 and it is proposed to erect and maintain an electric light plant.

EVANSTON.—The Evanston Interurban Railroad Company has been incorporated for the purpose of operating a street railway and an electric light and power plant. The company is capitalized at $5000. E. F. Clapp and F. J. Kinsley are interested in the project.

EAST ST. LOUIS.—At a recent meeting of the City Council the Illinois Illuminating Company asked for the passage of ordinances granted it the right to erect poles and string wires in East St. Louis, in order that it might furnish electricity for light and power purposes.

INDIANA.

HAMMOND.—The South Shore Gas & Electric Company has commenced the construction of its West Hammond system.

FRANKFORT.—The local electric light plant has been purchased by F. M. Ingler, who, it is said, contemplates making improvements in the plant to the amount of $20,000.

ELKHART.—It is reported that the Indiana & Michigan Electric Company is preparing plans for the construction of a transmission line from its dams along St. Joseph River to distribute current to Indianapolis and Louisville, Ky.

INDIAN TERRITORY.

CHICKHASHA.—The contract for the erection of the new electric lighting plant here has been let to L. Martin.

COALGATE.—The Coalgate Company has been granted a 20-year franchise for the construction and operation of an electric light plant in this town.

IOWA.

GORIN.—D. A. Frazee and J. K. Hackett have petitioned the Town Council for an electric light franchise.

RED OAK.—The Red Oak Electric Company has made application to the Council for the right to use the streets of the city.

SHENANDOAH.—The Shenandoah Artificial Ice, Power, Heat & Light Company is said to have purchased the local light plant and will make extensive improvements.

LENOX.—The Lenox Electric Light & Power Company, with a capital of $1800, has been incorporated by T. W. Bennett and others, and has been granted a local franchise.

SIOUX CITY.—The citizens voted recently to grant a franchise to E. Tilden, president of Libby, McNeil & Libby, Chicago, and Samuel McRoberts for the construction of a heating and electric light plant.

CHARLES CITY.—A. L. Dodd writes that he is interested with others in the construction of an electric light plant here to cost $25,000. Bids for the construction will probably be received about February or March.

WAVERLY.—At a meeting of the City Council it was decided to purchase the plant of the Healey Electric Light Company for $13,500. The transfer has been made and the plant will in the future be operated as a municipal plant.

KANSAS.

LAWRENCE.—Mr. George Dawes is now president of the Lawrence Gas, Fuel & Electric Light Company.

WICHITA.—The City Council has granted to the Citizens' Electric Light, Heat & Power Company a franchise for an electric light and heating plant.

COFFEYVILLE.—Arrangements have been made to sell the machinery comprising the present equipment of the municipal lighting plant and to replace the same with an entire new outfit. The capacity of the plant will be considerably increased and the service improved. E. L. Rossiter is superintendent and purchasing agent and P. G. Walker is chief engineer and electrician.

KENTUCKY.

FORDSVILLE.—The Board of Trustees has passed a resolution for the building of an electric light plant and it is thought that the construction work will soon be under way.

UNIONTOWN.—Mr. G. F. Cecil is manager and purchasing agent of the Uniontown Electric Light Company. The company has the city lighting contract and runs on an all-night schedule.

PADUCAH.—It is proposed to install a new electric light plant at a cost of $20,000. The present one has been in operation since 1894 and much of the equipment needs replacing. It is also inadequate to meet the increased demands being made upon the plant, and it is deemed advisable to install a new outfit.

LOUISIANA.

PLAQUEMINE.—Victor M. Garber, of Shreveport, has been granted a franchise for the establishment of an electric light and power plant. Arrangements have been made for the purchase of the necessary building site in the rear of the water works plant and work will soon begin on the construction of a brick building in which to house the plant. According to the terms of the franchise, the town will be supplied with forty 1500-c.p. arc lights at an annual cost of $2400. Mr. Garber will also run the water works under a special agreement with the town authorities.

MAINE.

WILTON.—The Wilton Electric Light & Power Company has been incorporated with a capital of $10,000. A. V. Adams is president, and C. N. Blanchard, treasurer, both of this city.

LEWISTON.—This city and Auburn are now being furnished with light from the new 10,000-h.p. plant which has been in course of construction for the past two years at Deer Rips.

BLAINE.—The Mars Hill & Blaine Electric Light Company has been organized to construct and maintain an electric light plant. The capital of the company is placed at $10,000. Almon O. Nutter, of Mars Hill, is president, and George W. Young, of Blaine, is treasurer.

SOUTH WINDHAM.—The Mallison Electric Light & Power Company, of this city, has been granted permission to extend its lines throughout the city for commercial lighting purposes. Work on the erection of poles and cables will begin at once. The franchise also includes Gorham and Little Falls. B. H. Elkins is superintendent of the plant.

ELLSWORTH.—Reports are heard of the formation of a new lighting company which will apply for a charter at the next session of the Legislature for lighting and heating this city and the towns of Trenton, Eden, Mount Desert, Tremont and Gouldsboro in the County of Hancock. T. F. Moran and Charles B. Pineo, both of Bar Harbor, are said to be the promoters of the project.

MARYLAND.

BALTIMORE.—The plant of the American Lighting Company is said to have been damaged by fire to the extent of $2500.

BEL-AIR.—Plans have been completed by the Susquehanna Electric Company for the construction of a large electric power plant on the Susquehanna River, and it is expected that active work will commence soon. It is proposed to erect a plant, the cost of which is estimated at $9,000,000, for the purpose of supplying electricity for manufacturing, lighting and power purposes. B. H. Welch, of Philadelphia, is president of the company.

BALTIMORE—The Baltimore Electric Power Company, the organization of which was reported in these columns last month, has perfected its plans for the construction of its lighting and power plant. The building and machinery contracts have been let, and it is hoped to have the plant in operation by the middle of next summer. The plant will be equipped with Westinghouse-Parsons steam turbines, and a storage battery system will be installed as an additional safeguard against any interruption of the service. The officers of the new company, who are also officers and directors of the Maryland Telephone & Telegraph Company, are as follows: President, D. E. Evans; treasurer, R. F. Bonsall; secretary, W. T. Spring. Pending a permanent organization, the directors are: H. W. Webb, D. E. Evans, John T Stone, W. T. Burroughs, R. F. Bonsall W. T. Spring and George R. Webb.

BALTIMORE.—The United Electric Light & Power Company announces that plans have been consummated for the erection of a large power plant. The company expects to spend about $1,000,000 for the property, building and equipment. A site of 22 acres immediately adjoining the city and having a water front of about 1000 feet, has been purchased from the South Baltimore Company. The plant will have an initial capacity of 13,000 horsepower, but will be planned to develop ultimately 50,000 horsepower. It is hoped to have the plant completed within a year. At present the United Electric Light & Power Company receives its power from the United Railways & Electric Company and distributes it through its own transformer station in McClellan Street. This station, together with the Monument Street and Penn Street steam-driven stations, will be connected by underground cables with the new waterfront station upon its completion.

MASSACHUSETTS.

MERRIMAC.—The municipal lighting and water plant has been completed, and the town now has a system which is efficient and up-to-date.

WEBSTER.—Up to the present time the town has been lighted on a midnight schedule, but the Council has voted for an all-night service and has made an additional appropriation for the purpose.

WARREN.—Work on the addition to the power station of the Consolidated Company here progresses rapidly. The building will soon be ready to receive the machinery and it is hoped to have it in operation before many weeks.

LEXONDALE.—The Washburn Electric Company has been incorporated, with a capital of $6000, by W. H. Washburn, L. H. Hubin and T. E. Moat, of North Adams, to develop a water power for the purpose of lighting the streets and public buildings by electricity.

WEST SPRINGFIELD.—Much interest is manifested in the question of municipal ownership of the electric lighting plant here. The proposition was voted down at a recent town meeting, but the citizens have called a mass meeting for a further consideration of the matter.

GREENFIELD.—The Greenfield Electric Light & Power Company is now furnishing power for the street railway company from its recently completed plant at Garner Falls and is also lighting the city from the same source. Officers of the company believe that it will not be long before it will be necessary to provide additional facilities for supplying light and power in order to keep pace with the demands. The company has petitioned for a franchise to erect poles and string wires for lighting Deerfield and South Deerfield.

HOLYOKE.—At the annual meeting of the Holyoke Water Power Company stockholders the following Board of Directors was chosen: C. M. Beach, J. J. Goodwin, Francis Goodwin, C. E. Gross and D. W. C. Skilton, of Hartford; S. D. Smith and L. L. Willcutt, of Boston; and Frederick Harris and A. W. Damon, of Springfield. The directors who have the matter of the new electric power plant in charge have organized and are considering preliminary plans for the construction of the plant.

MICHIGAN.

DETROIT.—The new $6,000,000 plant of the Detroit Edison Company is now nearly completed. It is already furnishing light to the western portion of the Edison Electric Light Company's subscribers.

FLINT.—The following are the officers of the Flint Light & Power Company: President, J. E. Durham; vice-president, J. J. Hurley; secretary and treasurer, A. G. Bishop; superintendent and chief engineer and electrician, F. A. Beard.

NEGAUNEE.—The Negaunee & Ishpeming Street Railway & Electric Company purposes increasing the capacity of its electric light plant by the addition of two 180-kw., 2300-volt, 60-cycle dynamos, together with an engine for same.

BENTON HARBOR.—Reports state that plans have been perfected by Charles A. Chapin, representing a water power company, for the transmission of electrical power from the dam at Buchanan to the twin cities. The cost of the dam is estimated at $750,000.

MINNESOTA.

MONTGOMERY.—J. E. Anderson and S. A. Votapek have petitioned for a franchise for an electric light plant.

MINNEAPOLIS.—The Joyce-Pillsbury Co. has been incorporated to establish an electric lighting plant. The company has a capital of $100,000 and numbers among its organizers N. C. Ackley and F. C. Goddard.

WINONA.—Henry M. Lamberton has secured a franchise for the Minnesota Light & Power Company to erect a large electric light and power plant on Rollingstone Creek at Minnesota City. Water power which formerly operated two flour mills has been purchased, and in addition to this a steam plant will be erected. It is proposed to furnish electricity for commercial lighting and power in this city and the surrounding towns and villages. It will also furnish the power for several proposed trolley lines, one of which has already been surveyed.

MISSISSIPPI.

YAZOO CITY.—R. C. Rimmer has resigned his position as chief electrician at the city light, water and sewerage plant to accept a position as superintendent of the electric light and water works at Clinton.

VICKSBURG.—The Vicksburg Water Power Company advertises a proposed amendment to its charter and it is given out that an electric power plant with a capacity of 300 horsepower will be added to the water plant. Manager Crumpler states that he will be in the market to furnish light and power by February.

MISSOURI.

JOPLIN.—The municipal lighting plant and the headquarters occupied by the East Joplin Fire Company have been destroyed by fire. The loss, it is said, will exceed $60,000.

SPRING VALLEY.—The Spring Valley Lighting & Power Company has been incorporated by John McFadden, Harry N. Brown and others. The company's capital is $100,000.

KANSAS CITY.—The Fort Scott Light & Fuel Company, of Kansas City, has filed articles of incorporation, with a capital of $150,000. The incorporators are J. B. Levy, of Garnett, Kan.; C. C. Nelson, of Fort Scott, and others.

JEFFERSON CITY.—The citizens have voted to grant a franchise to the Chicago syndicate which recently purchased, through its representative, W. N. Horner, the plant of the Jefferson City Light, Heat & Power Company for $80,000. The new owners propose to rebuild and enlarge the plant.

MONTANA.

KALISPELL.—Jeremiah Miller and others have formed the Montana Water Power & Electric Company with a capital of $2,000,000 to construct a power plant and a trolley line.

PHILLIPS.—The Papoose Mining Company has been incorporated to operate in Kings Gulch, Chouteau County, and build plants for the generation and transmission of electric power to be used at mines, mills and smelters. The company's capital is $20,000 and the directors are Charles Whitcomb, of Zortman; Ben D. Phillips, of this city; Robert J. Coburn, of Brookside, and William F. Word, of Helena.

HAVRE.—The plant of the Havre Electric Light & Telephone Company has been sold to Turner & Hebgen, of Butte, who have filed articles of incorporation for the Havre Electric Company, having a capital stock of $100,000. The new company will remodel the plant and install sufficient new machinery to double its capacity. A steam-heating station will also be installed in connection with the plant and the mains are now being laid through the principal streets in the business section of the city.

NEBRASKA.

ASHLAND.—The Ashland Light, Mill & Power Company has filed articles of incorporation, showing a capital stock of $15,000. C. H. Brown, J. C. Ralsbock and F. E. White are the incorporators.

PLATTSMOUTH. — The Nebraska Lighting Company, a new organization with a capital of $100,000, of which Charles G. Parmele, of this city, is president, has purchased the property of the old Plattsmouth Gas & Electric Light Company. The system is to be practically rebuilt and the city is promised a first-class light service, such as it has not had for some time.

ARLINGTON.—A new light plant is being installed here at a cost of $5000.

KEARNEY.—R. E. Frey is now secretary and treasurer of the Northwestern Electric Heat & Power Company.

LINCOLN.—Contracts have been awarded for constructing the electric light plant and work will begin at once.

NEW JERSEY.

WEEHAWKEN.—The Weehawken Contracting Company, who recently secured the thirty years contract for lighting this township, has completed the changes necessary to fulfill the contract and the town is now lighted from the company's plant.

IRVINGTON.—The feasibility of municipal ownership of a lighting plant for Irvington is being widely discussed. A committee has been appointed to secure information regarding the probable cost of a system, and a thorough investigation of the matter will be made.

LONG BRANCH.—The Elberon Water & Light Company has filed articles of incorporation, fixing the capital stock at $150,000. The incorporators are Raymond S. Dodds, James Loux and William J. Maccohl, all of this city. The company purposes constructing and operating a water works system and an electric lighting plant.

NEWARK.—At a meeting of the Board of Directors of the Public Service Corporation held recently at its office in the Prudential Building, an issue of $7,250,000 of 5 per cent, 5-year collateral trust bonds of the corporation was authorized. The money received from the sale of the bonds is to be used in improvements throughout the various systems of the corporation. The trolley, gas and electric light plants are to be enlarged and improved.

NEW YORK.

WATKINS.—Bonds to the amount of $20,000 have been sold for the construction of a municipal electric light plant.

ONEIDA.—The Board of Public Works is advertising for bids for lighting the streets and public buildings by electricity for a period of either two or five years.

NORTH TONAWANDA.—The question of constructing a municipal lighting plant is under discussion and will probably be submitted to the people.

TANNERSVILLE.—The Tannersville Electric Light & Power Company has been recently organized and expects to be ready to supply electricity to both Hunter and Tannersville by June 1, 1905.

NEWARK.—A contract has just been entered into with the New Light, Heat & Power Company by the city for lighting the streets during a period of five years at $85 per 2000-c.p. arc lamp per year.

ONEIDA.—Dewitt C. Hadcock, C. E., of this city, states that bids will probably be received about January 1 for the construction of an electrict power plant at Limekiln Falls, to cost about $125,000.

SYRACUSE.—The stockholders of the Syracuse Lighting Company have authorized the placing of an order for a new battery of boilers at the electric light plant. The new equipment will cost $25,000.

WESTCHESTER.—Under the management of the New York & Westchester Lighting Company, which now controls the Westchester Lighting Company, extensive improvements in the system of the latter company are contemplated.

TOTTENVILLE, S. I.—The Tottenville Lighting Company has been incorporated to operate in Richmond County. The directors of the company, which is capitalized at $25,000, are W. E. Cook, W. H. Gahagan and J. F. McCarthy, of Brooklyn.

LIVINGSTON MANOR. — The Livingston Manor Electric Company has been incorporated to manufacture electricity. The capital is said to be $32,000 and among the incorporators are V. A. Finch and George S. Wollson, both of this city.

TANNERSVILLE.—The Schoharie Light & Power Company has filed articles of incorporation with a capital of $40,000. C. E. Hewitt and M. G. Hubbard, of Chatham, N. J., and H. A. Heyn, of New York City, are among the directors.

KIRKLAND.—The Oriskany Light & Power Company has secured a franchise from the Town Board to erect poles and string wires for the transmission of electricity for power purposes. The company expects to construct a concrete dam at Millburn very shortly.

GOUVERNEUR.—The Village Trustees have contracted with the Oswegatchie Light & Power Company to light the village for five years at $60 per arc light per year for the first two years for midnight service only, and at $75 per light per year for the remaining three years on an all-night schedule.

CLIFTON SPRINGS.—The various contracts for the new electric light plant to be erected here have been let and the work has been commenced and will be pushed as fast as possible. Nearly all the poles for the eight miles of circuit have been received and the work of setting them will begin at once.

PENN YAN.—The power house of the new municipal electric plant at the water works pumping station has been completed and the machinery is being installed. The 600 poles required for the lighting circuit have been set and the work of stringing the wires is nearing completion. It is expected that the plant will be in operation by December 15.

SARATOGA SPRINGS.—The Saratoga Gas, Electric Light & Power Company has secured the contract for lighting the streets and public buildings for four years on the following terms: $90 per light per year for 2000-c.p. arc lights, $25 per year for 20-c.p. gas lamps, and for public buildings gas is to be furnished in 16-c.p. lights at $1.50 per thousand cubic feet.

BROCKPORT.—The Albion Electric Light, Power & Gas Company is now prepared to furnish electric power and light to this village from its Waterport power house over a 25-mile transmission line. The system has been in operation for nearly two years and the service so far as utilized has been satisfactory. The company furnishes power for A. Tooley & Co.'s planing mill here.

NORMANSVILLE.—The Albany Electric Power Company purposes expending $100,000 in improvements in the immediate future. The office of the company is located in this place and William H. Slingerland, Jr., is president and Charles W. Bentley, secretary. The company owns water rights along the Normanskill Creek which it is proposed to develop for the operation of an electric power plant.

BUFFALO.—The International Current Power Company has been incorporated by Henry Lewis, Edward Delahunt and Thomas McDonald, of Buffalo. The company is capitalized at $100,000 and will manufacture a newly patented water wheel. It is said, however, that as soon as a site can be selected a power plant will be erected also for the generation of electricity which will be furnished to the public for heating, lighting and power purposes.

SCOTTSVILLE.—Merton E. Lewis and Henry C. Brewster, of Rochester, and Isaac W. Salyerds and David C. Salyerds, of Scottsville, have organized the Scottsville Electric Light & Gas Company for the purpose of generating and distributing electricity in the towns of Scottsville, Caledonia and Rush. The concern is capitalized at $20,000 and will also manufacture and sell artificial gas in addition to supplying natural gas if it can be obtained in the vicinity of the three towns.

MIDDLETOWN.—The properties, rights, privileges and works of the Orange County Gas & Electric Light Company of this city, were sold at foreclosure to Philip N. Jackson, of Newark, who formerly owned a controlling interest in the company, and who represented himself and other bondholders. The Neversink Light & Power Company claims the transformers, switches and other high-potential apparatus used at the electric plant which has been installed since that company has procured its power from the Neversink Company's power plant at Cuddebackville. Mr. Jackson states that the new company will begin an aggressive business policy with the intention of giving the best possible service at reasonable rates.

ROCHESTER.—Measuring instruments have been purchased by the city for the purpose of testing the quality of the light supplied by the Rochester Railway & Light Company. The question of changing from open to enclosed arc lights for the street lighting system is being discussed and the city engineer was asked to make a report on the various points involved. This report gave in detail reasons for making the proposed change. Among others a comparison was made between the outages of the enclosed arcs and the open arcs, taken from the reports of the Police Department for the first seven months of the year 1903, as follows: Total number of arc lights, 2190. Total number reported out over one-half hour, 2106; an average per night of 8.67, or forty one-hundredths of one per cent. During the same period there were 614 enclosed arcs. Total outages reported for the same time, 120; an average of 0.50 lamps per night, or eight one-hundredths of one per cent. The percentage of outages of the enclosed arc was therefore a little less than one-fifth of that of the open arc.

NORTH CAROLINA.

MT. OLIVE.—William Maxwell, J. W. Williamson, and others, recently organized and incorporated the Mt. Olive Light & Power Company, with a capital of $100,000. The contract for constructing the company's proposed plant has been let to the Standard Electric Company, of Charlotte.

FAYETTEVILLE.—The Cape Fear Electric Power Company has about completed its dam near here. The dam is 1500 feet long, and backs up the water for twelve miles. A number of cotton mills and manufacturers, as well as the new cotton mill to be built by the company at Fayetteville, will make use of the new power.

GOLDSBORO.—The city electric light plant is undergoing some greatly needed repairs under the supervision of Superintendent John S. Dortch. For some time past the street lights have been unsatisfactory, owing to the fact that the boilers would not generate sufficient steam to carry the lighting load. Two new 200-h.p. boilers have been installed in place of the old ones, which nearly doubles the boiler capacity of the plant, and the service has been much improved.

SALISBURY.—Reports are to the effect that the work of developing the enormous water power available at the "Narrows" on the Yadkin River, about eighteen miles from this city, will be resumed and pushed to rapid completion. C. L. Whitney, president of the Whitney Reduction Company, and the company's secretary, together with a company of surveyors and contractors, were here recently with a view to ascertaining just what material and other requirements would be necessary for the completion of the plant. It is estimated that the work will cost about $5,000,000.

NORTH DAKOTA.

FARGO.—The contract for lighting the streets and public buildings for one year has been awarded to the Union Light, Heat & Power Company, of this city, for $8000.

OHIO.

ZANESVILLE.—The Board of Public Service has called for bids for lighting the streets of the city for a period of one year.

MARTINS FERRY.—Bids have been called for by the Board of Public Service for furnishing a 425-h.p. engine to be installed in the municipal plant.

LEXINGTON.—An ordinance for the construction of a new lighting plant has been passed by the Council and the franchise granted to H. F. Smith.

NORWALK.—It is proposed to let the contract for lighting the city for ten years. Plans and specifications can be procured by writing to the City Clerk.

CANTON.—Anthony Howells and William L. Davis, with others, have organized the Citizens' Heat, Light & Power Company. The company is capitalized at $100,000.

DAYTON.—The Dayton Electric Light Company is perfecting plans for placing all its wires in underground conduits. This improvement will cost probably $100,000.

CLEVELAND.—Articles of incorporation have been filed by C. L. Denton, A. Lewenthal, H. L. Caldwell, and others, for the Cuyahoga Light & Power Company, with a capital stock of $25,000.

CHESTERHILL.—The Chesterhill Fuel & Light Company has filed articles of incorporation, stating its capital stock to be $16,000. Carl Patterson and R. G. Mains are among the directors.

NEWARK.—The city was without light for a short time recently owing to an accident at the municipal light plant. The large pulley burst and necessitated overhauling considerable of the machinery.

COLUMBUS.—The new lighting plant, for which bonds to the amount of $65,000 were recently issued, will be in operation by the 15th of January, according to Superintendent Wilcox. The plant will furnish current for 1800 arc lights.

CLEVELAND.—Plans are being discussed by the Board of Public Service, pending the annexation of South Brooklyn to the city, whereby the Brooklyn lighting plant may be used as a nucleus for a large municipal lighting plant for the entire city. The proposition to erect such a plant was voted down by the Council last winter. The South Brooklyn works were erected on a bond issue of $30,000, and it is claimed that $150 a month has been saved since the installation of the plant.

OKLAHOMA TERRITORY.

GUTHRIE.—The Guthrie, Fairview & Western Railway Company is contemplating the building of a modern electric lighting plant.

OKLAHOMA CITY.—The City Council has passed an ordinance granting a franchise to F. C. French and A. B. Crockett to operate an electric light, power and heating plant.

OKLAHOMA CITY.—Articles of incorporation have been filed by the Territorial Engineering Company, organized to construct and operate street railways and electric light and gas plants, with headquarters in this city. The company's capital stock is $25,000 and the incorporators are G. W. Burke, F. H. Peckham and H. L. Cunningham.

OKLAHOMA CITY.—In the recently effected reorganization of the Oklahoma Gas & Electric Company, the following officers and directors were elected: C. B. Ames, president, Oklahoma City; H. M. Byllesby, Chicago, vice-president; D. T. Flynn, Oklahoma City, secretary; A. H. Grimes, Guthrie, treasurer, and Rufus C. Dawes, Chicago; Samuel Insull, Chicago, and H. M. Newton, Sparta, Wis., directors; R. J. Graf, Chicago, assistant secretary and treasurer. H. M. Byllesby & Co., Chicago, were retained as engineers for the company. The company has issued bonds to the amount of $1,000,000, the proceeds of which will be expended in improving and extending the plant.

GUTHRIE.—The Guthrie Electric Light & Power Company has been incorporated with a capital stock of $150,000. The new company has acquired the stock of the Electric & Gas Light Company, the old light concern, which will be merged into the Guthrie Electric Light & Power Company. The plant will be enlarged and improved. The directors are Thomas H. Smith, of Denver; J. R. Cottingham and U. C. Guss, of this city. The company has been granted a twenty-year franchise by the Council, under the terms of which the city is to be furnished with free lights for the fire stations and city hall, making a total of 94 incandescent lights supplied gratis, besides a large arc light at the rear of fire station No. 1.

OREGON.

DALLAS.—Articles of incorporation have been filed by the Dallas Light & Power Company, with a capital stock of $1000. Harry V. Gates and D. P. Stouffer, with others, were interested in the organization of the new concern.

LA GRANDE.—The La Grande Water Storage Company is perfecting plans for the construction of an electric light plant which will cost in the neighborhood of $100,000.

MEDFORD.—A new company under the name of the Southern Oregon Power Company has been organized to do business in the Rogue River valley in the southern part of the State. The capital stock is fixed at $500,000. Jesse W. Churchill, of Yreka, Cal., is president of the company, and Alexander J. Rosborough, of Oakland, Cal., is secretary. The dam and power house at Gold Roy, on Rogue River, are finished and the power line is already built to Medford. The company hopes to complete the entire project in six months and expects to find a ready market for its output in the mines and lumber districts and for irrigation purposes. It will also light the town of Jacksonville, it is said.

PENNSYLVANIA.

DANVILLE.—The Borough of Danville is issuing $20,000 worth of bonds for the construction of an electric light plant.

WOMELSDORF.—The citizens have voted in favor of issuing $8000 bonds for the establishment of an electric light plant.

BEAVER SPRINGS.—The Beaver Springs Electric Light Company has filed articles of incorporation fixing its capital stock at $6000.

PITTSBURG.—The Wilkins Electric Power Company, with a capital of $5000, has been incorporated by R. T. Russell, J. G. Frazer and others.

ABERDEEN.—The question of bonding the town for $8000 for the purpose of installing an electric lighting plant was carried at the recent election.

PENN.—The Taylor Electric Power Company, organized by J. G. Evans, R. T. Frazer and others, has filed articles of incorporation with a capital stock of $5000.

WEST CHESTER.—The Borough Council is said to have renewed the contract with the Edison Electric Illuminating Company for lighting the streets of the town for a period of five years at $10,055 per year.

PHILLIPSBURG.—The Electric Light Company has secured the contract for lighting the streets by electricity for a term of five years at $80 per light per year and $10 per light per month for the borough buildings.

TELFORD.—A charter has been granted to the West Telford Electric Light & Power Company for supplying the borough and adjacent territory with electricity for light and power purposes. Morris A. Clymer, of Sellersville, is one of the incorporators.

BRADDOCK.—Bessemer Light & Power Company has been incorporated by J. G. Frazer, J. G. Evans, R. T. Russell, and others, who are also interested in the Taylor Electric Company of Penn Township. This company, like the other, is capitalized at $5000.

MAHAFFEY.—Parties associated in the iron works plant here are said to be interested in the Mahaffey Electric Company, capitalized at $5000. The plant will be operated in connection with the iron plant. The Borough authorities have agreed to take a minimum number of street lights for five years.

PITTSBURG.—Mayor W. B. Hays has signed the ordinance granting a franchise to the Duquesne Light Company. The company proposes to install a plant at an estimated cost of $2,500,000, and construction work will begin at once. Robert C. Hall is president, and S. P. Austin, secretary. The same interests which control the Pittsburg & Allegheny Telephone Company are said to be in control of the Light Company.

McKEESPORT.—A deal which has been pending here for some time has been consummated in the consolidation of the Tube City Brewing Company, the People's Ice, Light & Storage Company and the People's Brewing Company. The new corporation will have a capital of $1,500,000. The Tube City Brewing Company is already in operation, the People's Ice, Light & Storage Company will be ready for operation within sixty days, while the People's Brewing Company has secured a charter and was owned by the stockholders of the storage company. It is the intention to manufacture electricity for lighting and general power purposes.

MONONGAHELA. — Extensive improvements are in course of construction at the plant of the Monongahela Electric Light Company, which have necessitated the building of an addition to the plant. A new 200-h.p. Heine safety boiler has been installed in place of the 75-h.p. boiler formerly in use; a new stack 100 feet high also will be put up, and new pumps, heaters and arc lights have been installed. It is understood, however, that these repairs are only temporary, as it is the intention of the company to erect a new station sufficiently equipped to supply both lighting and power service. William Ewing, Sr., superintendent of the plant.

TROY.—The Council has made a contract with the Troy Gas, Power, Heat & Electric Company, by the terms of which Troy will soon have a first-class system of public and private electric lighting. The cost to the village for an all-night, every-night service, from nineteen 2000-c.p. arc lights will be $1500 a year for a period of ten years. Twelve hundred and fifty dollars was paid the old company latterly for seventeen lights run until midnight on a moonlight schedule. The plant will be located just off Canton Street, on part of the woolen mill property, and will consist of a 160-h.p. boiler made by the E. Keeler Co., of Williamsport, and fitted with a water heater and automatic pump or injector, a Hamilton Corliss engine of 160 horse-power, and a 2500-light Warren alternating-current dynamo. The engine and dynamo will be located in the engine house now on the lot. A new brick building will be erected at once for the boiler.

SOUTH CAROLINA.

ANDERSON.—A charter has been granted to the Piedmont Electric Company, with a capital of $25,000. The incorporators are E. S. Moorer, G. W. Evans and H. H. Watkins.

WALHALLA.—W. B. Frink, of New York City, and James Thompson and W. J. Stribling, of Walhalla, have organized a concern known as the Oconee Water, Light & Power Company. At present the capital stock of the company is $5000, but under the charter it may be increased to $250,000. This probably will be done shortly, as it is proposed to construct a plant which will cost from $100,000 to $120,000.

CHARLESTON.—A charter has been issued to the Broad River Light & Power Company, organized by local parties and capitalized at $1,000,000. Among others interested in the new corporation are J. L. David, J. H. Dingle and Walter H. Green. Water rights have been purchased at points above and below Lockhart Shoals, on Broad River, near this place. It is the intention to erect a dam above the shoals and pour the water through the old State canal, which was built before the war to enable boats and cotton rafts to go around the shoals. Below the site of the Lockhart mills a power house will be erected, and the electricity thus generated will be transmitted to various parts of the state.

SOUTH DAKOTA.

SIOUX FALLS.—An important transaction has just been consummated, involving the transfer of the local electric light plant, the dam in Sioux River, and what is known as Cascade mill, all being the property formerly of the Cascade Milling Company. The new owners have assumed control of the property; they are Pitt Curtis, a banker of Norwalk, Ohio, and Arthur Huntington and W. G. Mack, of Omaha. A company has been organized with Mr. Huntington as president; Mr. Curtis, vice-president, and Mr. Mack, secretary and treasurer.

TENNESSEE.

DYER.—The new plant of the Dyer Electric Company has just been completed, and the town is again lighted. The old plant was burned recently, and no effort has been spared to rebuild it with as little delay as possible.

SPRINGFIELD.—Work on the new electric lighting plant is progressing rapidly. When it is completed, the Council will be prepared to accept the proposition recently received from Adairville, Ky., twelve miles distant, to furnish lights for that town.

KNOXVILLE.—The following are the present officers of the Knoxville Electric Light & Power Company: President and manager, C. H. Harvey; vice-president, A. H. Rutherford; secretary, Leon Fender; treasurer, H. L. Bunn; superintendent, P. E. Mitchell; chief engineer, James Link; chief electrician, H. M. Moses.

JACKSON.—The Jackson Light & Power Company is the name of a new corporation with a capital stock of $25,000, which proposes to erect and operate an electric power plant in Jackson. It is claimed the present plant owned by the Jackson Street Car Company is not sufficient to meet the increased needs of the growing city. The present company has an exclusive privilege from the city, but the new company has asked for a franchise and an ordinance to that effect has passed one reading of the Board of Mayor and Aldermen, and under the rule will lie over till a subsequent meeting. Among the names of the incorporators of the new company are F. B. Fisher, I. B. Tirgrett, G. S. Baird, A. K. Kobe, E. L. James and John W. Buford.

CHATTANOOGA.—The Council has accepted a new contract from the Chattanooga Electric Company for lighting the city for five years at the rate of $6.49 per arc light per month, or $77.89 per light per year. This will permit the board to place twenty additional street lights with an expenditure of the same amount as under the present contract. With the same number of lights as used at present, 226, the city will save over $1600 per year for the next five years. However, additional arc lamps are needed and several will probably be ordered in the near future. By the terms of the contract the Chattanooga Electric Company will at once equip all street lighting circuits with the new alternating current lights. There are two circuits now in use. The others are to be completed within ten days after the company is officially notified that the contract has been entered into by the municipal authorities.

TEXAS.

EL PASO.—Mr. H. T. Edgar is now vice-president and manager of the International Light & Power Company.

LONGVIEW.—The Longview Ice, Light & Bottling Company will shortly install a new high-speed automatic engine.

CARTHAGE.—J. C. Whitney, proprietor of the electric light plant here, contemplates a complete reconstruction of the lines.

COOPER.—The Cooper Light Manufacturing Company is now known as the Cooper Electric Company, of which James W. Hockaday is proprietor.

TEXARKANA.—The Texarkana Gas & Electric Light Company, of Texarkana, Ark., will install in its plant here a new direct-connected alternating-current generator and Corliss engine.

PITTSBURG.—J. F. Allbright is manager and purchasing agent of the local plant of the Arkansas Consolidated Ice & Coal Company, of Marshall; M. R. Buchanan is chief engineer anl electrician.

DUBLIN.—George House, who has had charge of the plant of the Dublin Light & Power Company for several years, has moved to Baird and taken charge of the Baird Electric Light Company's plant. He succeeds J. B. Miller, superintendent, who has returned to Llano, this state.

DALLAS.—Bids will be received until December 6 for lighting the city, as follows: To furnish on a five-year contract from 350 to 600 arc lights, moonlight and all-night schedule each, and for plans and specifications for a lighting plant for the city with a capacity of from 500 to 1000 arc lights; also separate bids for putting in the power plant, the lighting machinery and the poles, lines and lamps thereof.

UTAH.

MILFORD.—J. W. Clark, of La Porte, Ind., is said to have secured the contract to light this town with electricity.

OGDEN.—The American Falls Canal & Power Company has been incorporated to operate in Bingham and Logan Counties. The company's capital is $500,000. Lyman Skeen is president and J. J. Brummitt, secretary.

VERMONT.

BURLINGTON.—The city expects to have its new municipal lighting plant in operation some time in February. The power house is nearly ready to receive the machinery. Fifty miles of wire will be required, which with the poles, will cost about $15,000.

NORTH TROY.—C. O. Fowler, owner of the plant run under the style of the North Troy Electric Light Company, has arranged to extend the line to the station, which will necessitate an all-night service. Heretofore the plant has been operated on a midnight schedule.

NORTHFIELD.—The municipal electric light plant was destroyed by fire on the 3d ult. The total loss was estimated at $20,000, with $10,000 insurance. The Almon-Moody plant at Moretown has been furnishing power for the lights since the city plant was burned. The Council is now considering whether to rebuild and equip the old power house or to purchase the necessary current for running the lights.

BRADFORD.—C. A. Prouty, of Newport, is reported to have purchased the mill property and water power of B. S. Hooker at Bradford, and a controlling interest in the Bradford Electric Lighting Company. He proposes in the spring to fully develop the power now owned by himself and the Electric Lighting Company. The power house will be located on the south side of the stream, and will be built of brick, made fireproof, fully equipped with modern machinery and run the entire twenty-four hours.

VIRGINIA.

STAUNTON.—The Board of Trade has passed resolutions petitioning the Council to enlarge the city electric plant.

CAPE CHARLES.—Heckle & Kellogg have applied to the Town Council of this city for a franchise to erect an electric light plant to furnish lights for the city. The plant will soon be erected.

LURAY.—A charter has been granted to the Luray Electric Company, with a capital of $15,000, to operate an electric light plant. E. C. Harnsberger is president and R. T. Morrison, secretary.

RICHMOND.—Reports state that at a conference of the Committees on Finance and Electricity a sub-committee of five was appointed with authority to employ an expert electrical engineer to prepare estimates of the cost, location, etc., for a municipal electric light plant.

MARTINSVILLE.—An option has been secured on the land and water power owned by R. J. Reynolds on the south side of Smith River, the same to be used as a site for a municipal electric light plant. The cost of the plant is estimated at $60,000. Bonds to that amount will probably be issued soon.

WINCHESTER.—At the recent monthly meeting of the City Council a report on the question of municipal ownership of electric street lights was submitted by Shirley Carter, chairman of the committee to whom the matter had been referred. Mr. Carter's report strongly advocated the city owning its own electric light plant, and the Council has taken the initiatory steps to that end. The question of municipal ownership of the electric light plant was raised several weeks ago, when the Winchester Gas & Electric Light Company, the owner of the present contract, informed the Council that it would charge $70 per lamp per year in future, instead of $55, which the city has been paying. The contract expires in December.

WASHINGTON.

NORTH YAKIMA.—It is reported that the Yakima Water, Light & Power Company will construct a new power plant near the intake of Wapatox ditch to generate electricity for this city and the electric railway.

SEATTLE.—An election will be held December 6 to vote on the issue of bonds as follows: $175,000 for the construction of a city jail, municipal court and hospital, and $250,000 for extensions and improvements to the present light plant. It has been decided to purchase the circuits of the Seattle Electric Company, for which $52,743.73 will be paid it is said.

SPOKANE.—D. L. Huntington, general manager of the Washington Water Power Company, states that it will be but a short time until conditions at Post Falls will be materially changed. The company will eventually have a power plant there with a total capacity of 18,000 horse-power. It is stated that the company expects in the near future to begin extensive improvements on its Spokane plant.

SEATTLE.—The Snoqualmie Falls Power Company has been reorganized under the name of the Seattle-Tacoma Power Company and its capital increased to $3,500,000. Extensive improvements are in contemplation by the company, including the installation of a 5000-kw. generator driven by a 9500-h.p. water wheel, which will practically double the capacity of the plant. The officers are: President, N. H. Latimer; treasurer, O. D. Calvin; general manager and secretary, Thomas B. Hardin; auditor, W. E. Best. The company will own the power plant at Snoqualmie Falls, as well as the properties in Seattle and Tacoma formerly operated under the names of the Seattle Cataract Company and the Tacoma Cataract Company. The White River Power Company, which is now building a big power plant with Lake Tapps, in Pierce County, as the main reservoir, will continue an independent corporation for the present, but will in all probability be merged later with the main corporation.

SEATTLE.—At the immense plant of the Puget Sound Power Company, located near this city, there are four General Electric revolving-field generators of 3500 kilowatts capacity each, with an overload capacity of 25 per cent. for two hours. Two 150-kw., 125-volt, 600 r.p.m. shunt-wound exciters are provided, each direct-connected to an overhung Pelton water wheel and to a 2080-volt, 200-h.p. three-phase induction motor. There are three banks of transformers installed at the power house, each bank consisting of three 2333-kw. water-cooled, oil-insulated, General Electric machines. These transformers have been operated at 55,000 volts from the beginning. For connecting each generator and transformer bank to the low-tension bus-bars a full complement of motor-operated oil switches is provided. Between each generator and each set of 2300-volt bus-bars there are two sets of disconnecting switches and a triple pole General Electric type H, 1200-amp. oil switch. Between the high-tension bus-bars and transformer banks there is a General Electric 60,000-volt, 400-amp. motor-operated oil switch and a set of disconnecting switches on either side of the oil switch. Each generator panel contains three ammeters, one voltmeter, a polyphase indicating wattmeter, a polyphase integrating wattmeter and a field ammeter. Each outgoing line panel contains three ammeters and the totaling panel contains a power factor indicator, a frequency indicator, a curve-drawing voltmeter and three curve-drawing instruments. These instruments belong to a type lately developed by the General Electric Company.

WISCONSIN.

MARKESAN.—The citizens have voted to issue bonds for the construction of an electric light plant.

KENOSHA.—Mayor James Gorman is said to have recommended the construction of a municipal electric light plant.

FENNIMORE.—The town is rejoicing in the possession of a new water and electric light plant which cost $20,000. The plant is owned by the town.

CORLISS.—The Brown-Corliss Engine Company has secured a franchise to erect water works and an electric light, heat and power plant here in the spring. The company expects to spend about $50,000 on the project. At present the town has no fire protection.

MAUSTON.—The Mauston Electric Service Company has acquired the light and telephone systems here. The plants will be remodelled and either a new dam constructed or the old one rebuilt.

NEW RICHMOND.—The new concrete dam of the Chicago Gas & Investment Company at Riverdale, on the Apple River, five miles northwest, is nearly completed. It will have a 23-foot head and develop 500 horse-power, costing, complete, $500,000. This is the fourth dam on Apple River, the total capacity being 2000 horse-power, and there is still room for two more dams to develop 500 horse-power each. The cost of equipment up to date is over $2,000,000. Most of the power is used in St. Paul and Stillwater.

WYOMING.

LANDER.—Edward Fanning, of Stewartsville, Minn., writes that he, with R. A. Morse, of this city, is interested in the construction of an electric power plant here to cost $50,000. The power will be used for running mines.

THERMOPOLIS.—The Thermopolis Electric Light & Power Company has announced its intention of building a new plant on the river above town. The old plant, which was supplied with power by water from the hot springs, was destroyed by fire recently. The new plant is to be located farther up the river and will derive power from cold water direct from the river. The company is understood to be in the market for an electrician who understands water power; all-night run; pay $100 per month.

CANADA.

NIAGARA FALLS, ONT.—The Electrical Development Company, Ltd., of Ontario, has awarded contracts, it is said, to the amount of $120,000 in connection with a proposed new power station.

VANCOUVER, B. C.—The Stave Falls Power Company has decided to issue $900,000, the proceeds to be devoted to the development of water power. The falls are about forty miles from New Westminster and it is estimated that about 25,000 horse-power is available.

CHARLOTTETOWN, P. E. I.—The City Council has engaged the De Lano Osborn Engineering Company, of Montreal, to prepare plans and estimates for a civic light and power plant. The question will be fully investigated before renewing any of the existing contracts with the local companies.

VICTORIA, B. C.—The Victoria Power Company has been organized, with authority to issue $750,000 bonds for the purpose of diverting the water from Koksilah River to Shawnigan Lake and conveying it to Mill Bay. The energy obtained will be used for industrial lighting and street railway service in Victoria and Esquimault.

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